Low Impact Development
Green Infrastructure and so much more…

Leslie Yetka
Education Manager – Minnehaha Creek Watershed District

MINNEHAHA CREEK
WATERSHED DISTRICT

Topics to cover…

The *Why*

- Impacts of stormwater runoff
  - Volume, rate, quality

The *What*:

- Regulations
  - Clean Water Act and MS4's
  - TMDL's

The *How*:

- Traditional Treatment
- Conservation/Smart Design
- Low Impact Development (LID)
- Green Infrastructure (GI)
- Benefits
- Maintenance

Topics to cover…

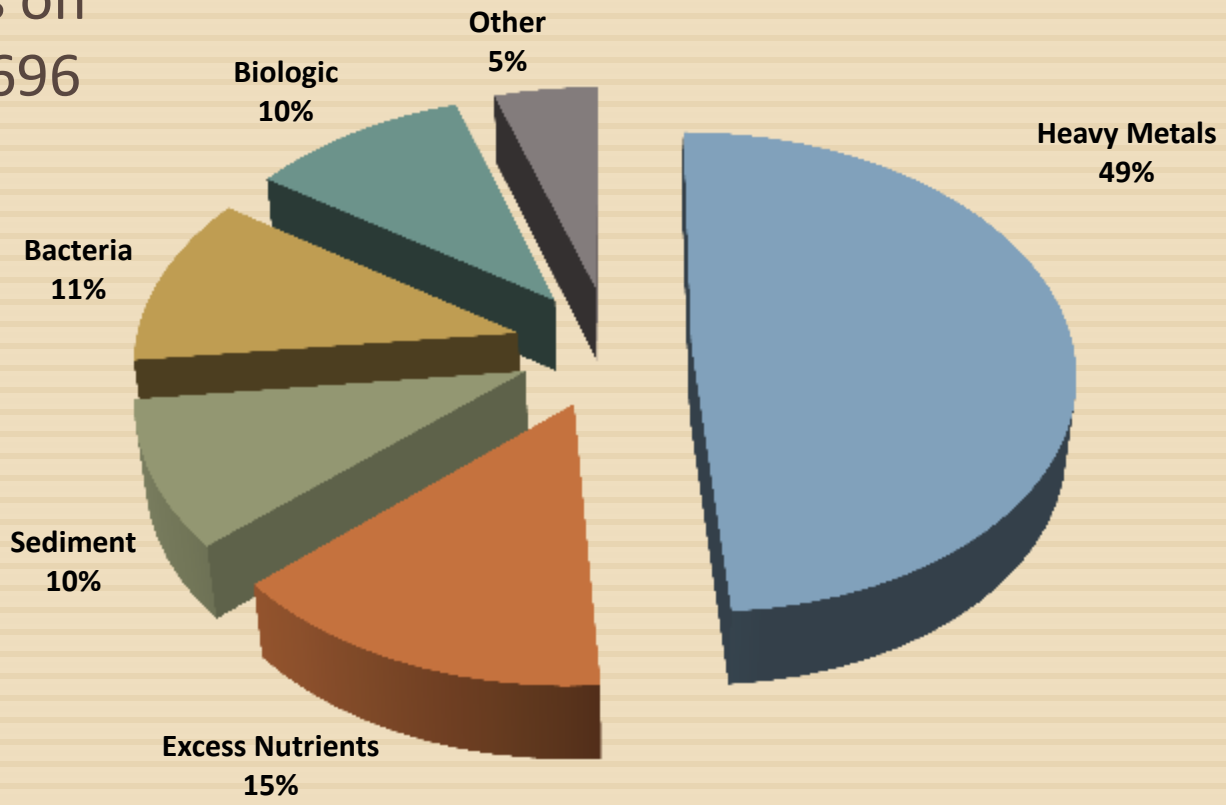
The *Why*

- Impacts of stormwater runoff
  - Volume, rate, quality

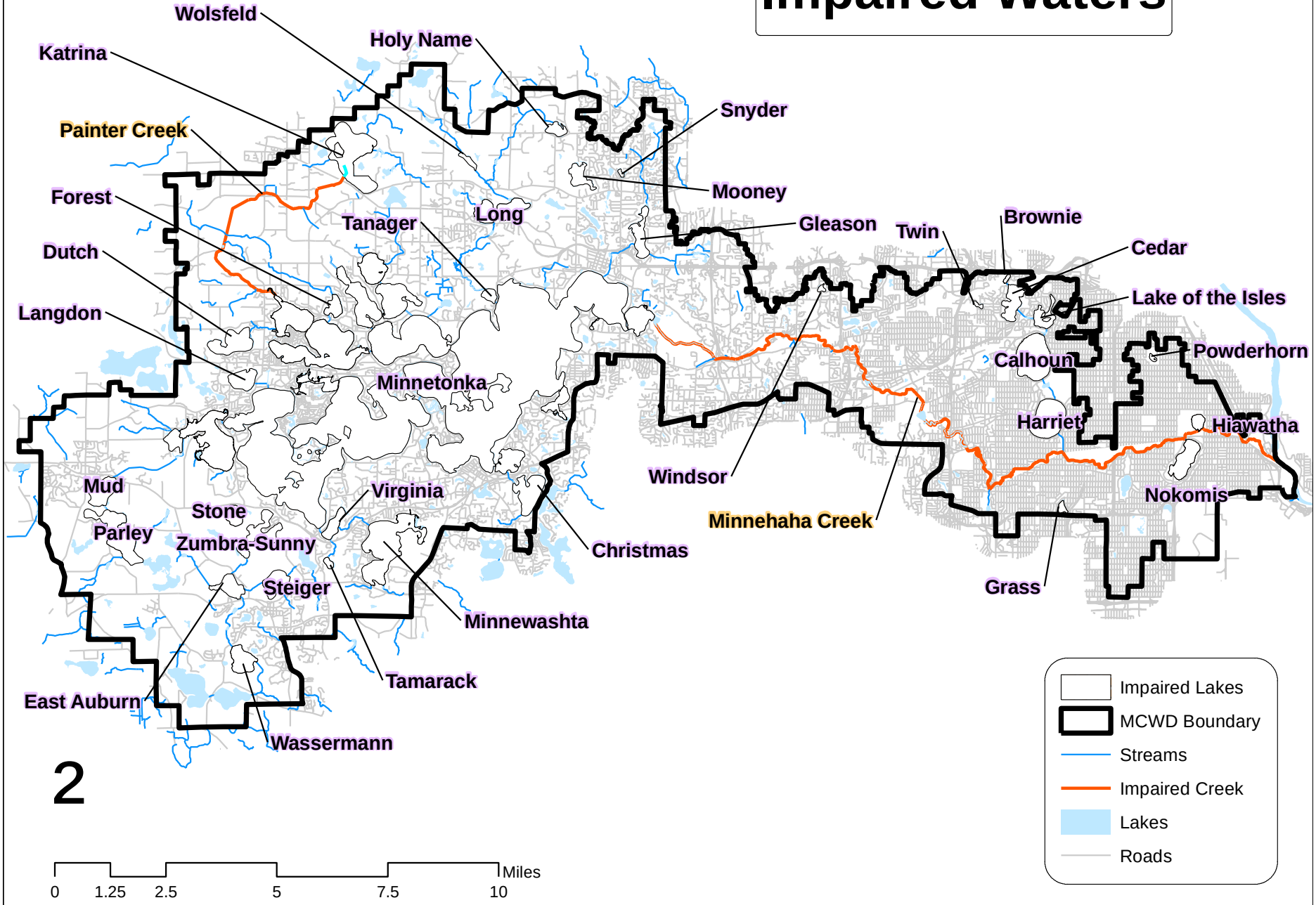
‘Impaired’ Lakes and Rivers

“303(d) list”

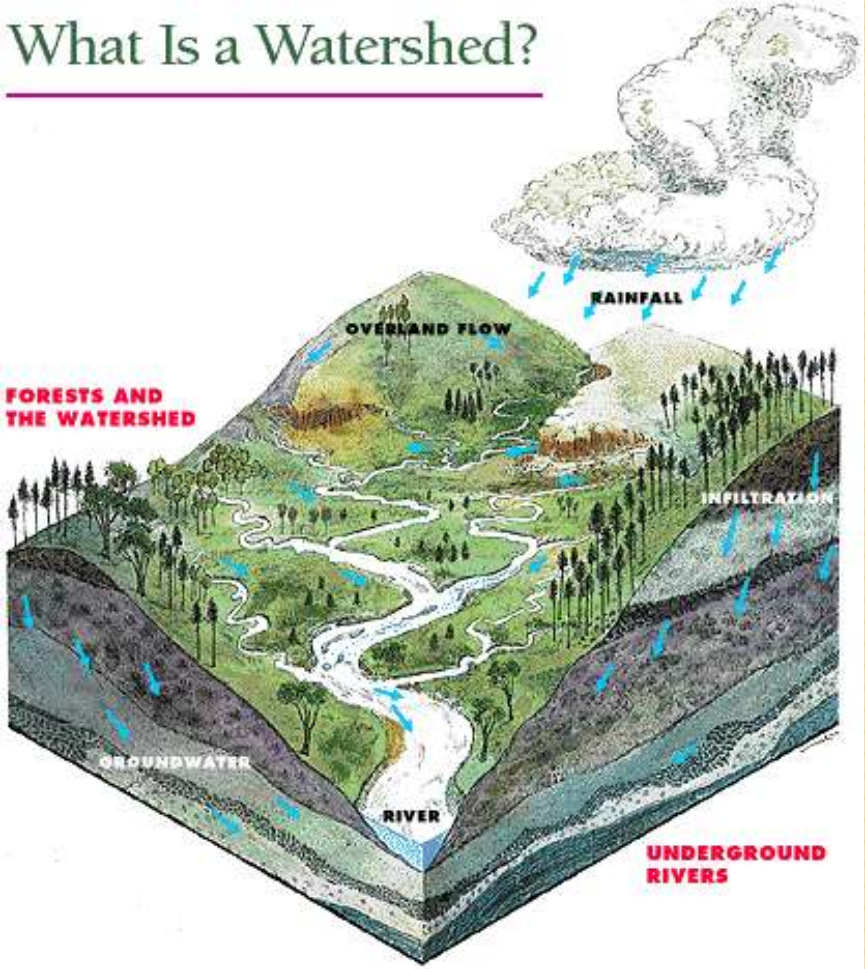
3,638 impairments on 400+ rivers and 1,696 lakes



Impaired Waters



What is a Watershed?



An area of land that drains into a body of water such as a lake, river, stream, or wetland.

What is Stormwater Runoff?

- Stormwater runoff is water flowing over land, plus anything carried along with it.
- Stormwater runoff comes from all forms of precipitation:
  - Rain
  - Snow
  - Sleet
  - Melting piles of ice/snow

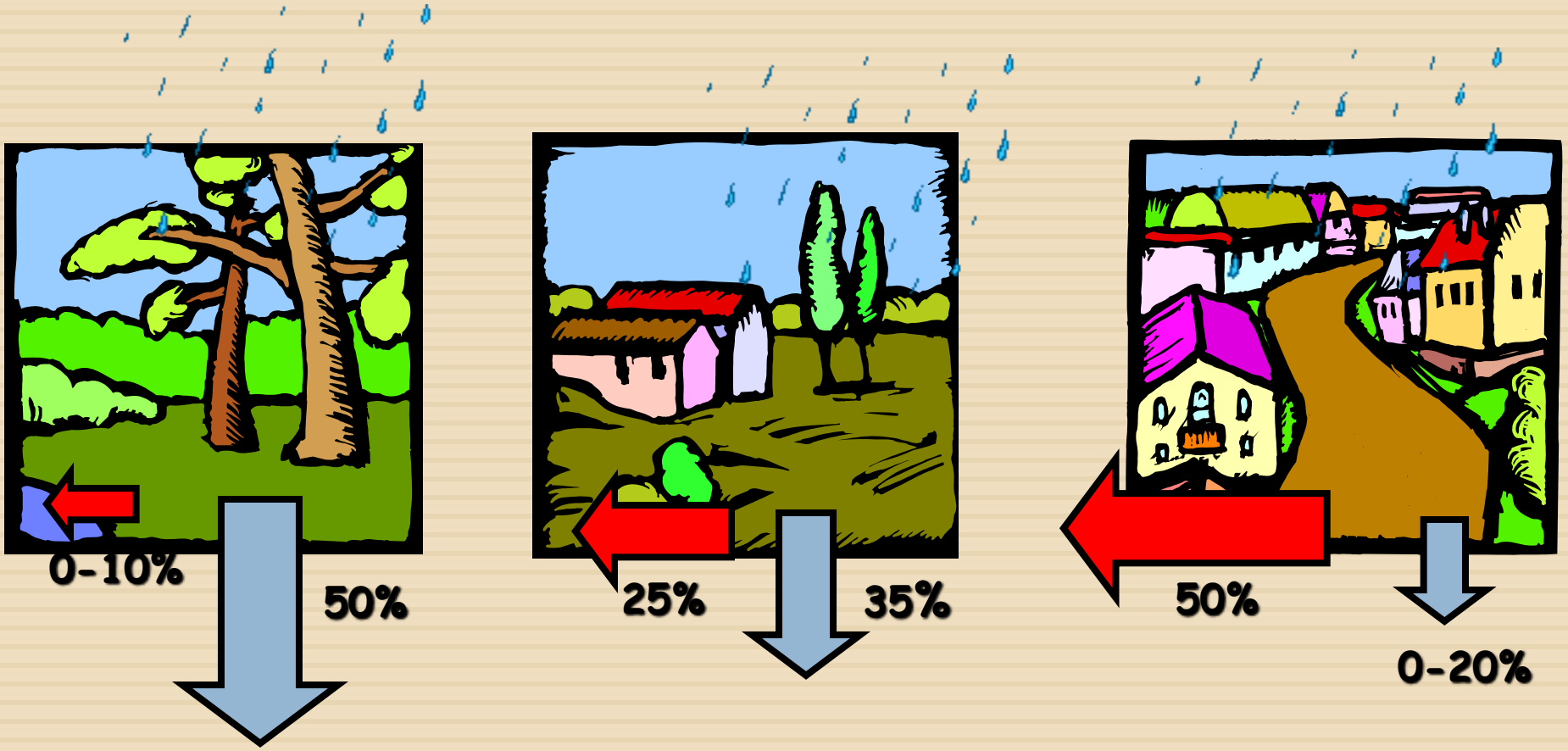
Urban runoff…

1. Quantity of water (*volume*)
2. What's in it (*quality*)
3. How fast it's moving (*rate of flow)*

Natural Area

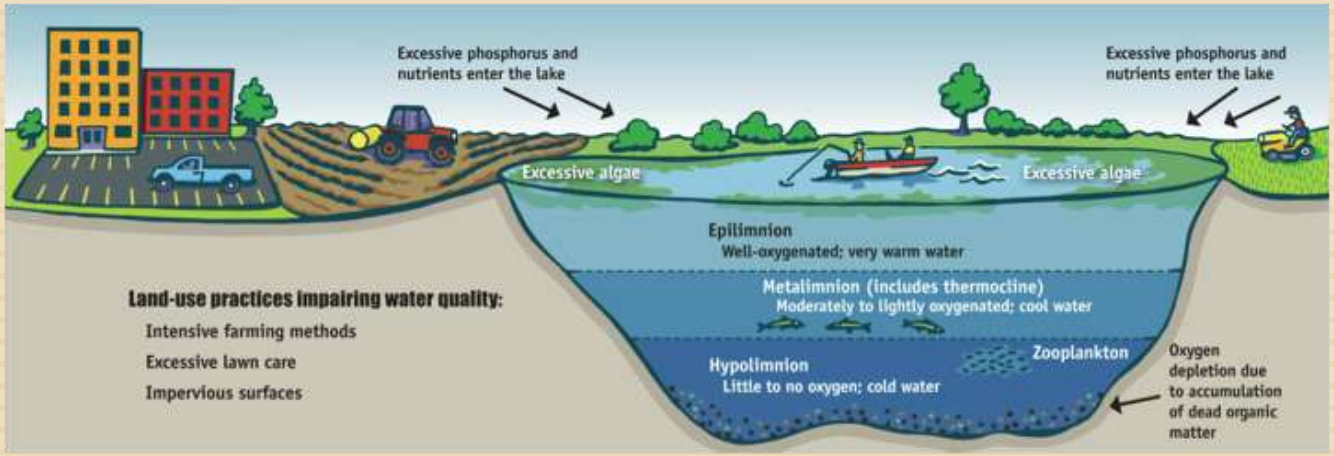
Some Development

Mostly Developed



Development Shortcomings

- Inadequately treated **runoff**
- Excessive runoff **volume**
- Lost **shoreline habitat,** aquatic and terrestrial
- Insensitive to **sensitive areas**



Rainfall – 24 hrs

Event frequency	Minnesota range (inches)	Twin Cities approximate average
1-year	1.8 - 2.6	2.4
2-year	2.1 - 2.9	2.75
5-year	2.8-3.7	3.65
10-year	3.3 - 4.4	4.2
25-year	3.9 - 5.0	4.8
50-year	4.4 - 5.6	5.3
100-year	4.8 - 6.2	5.95

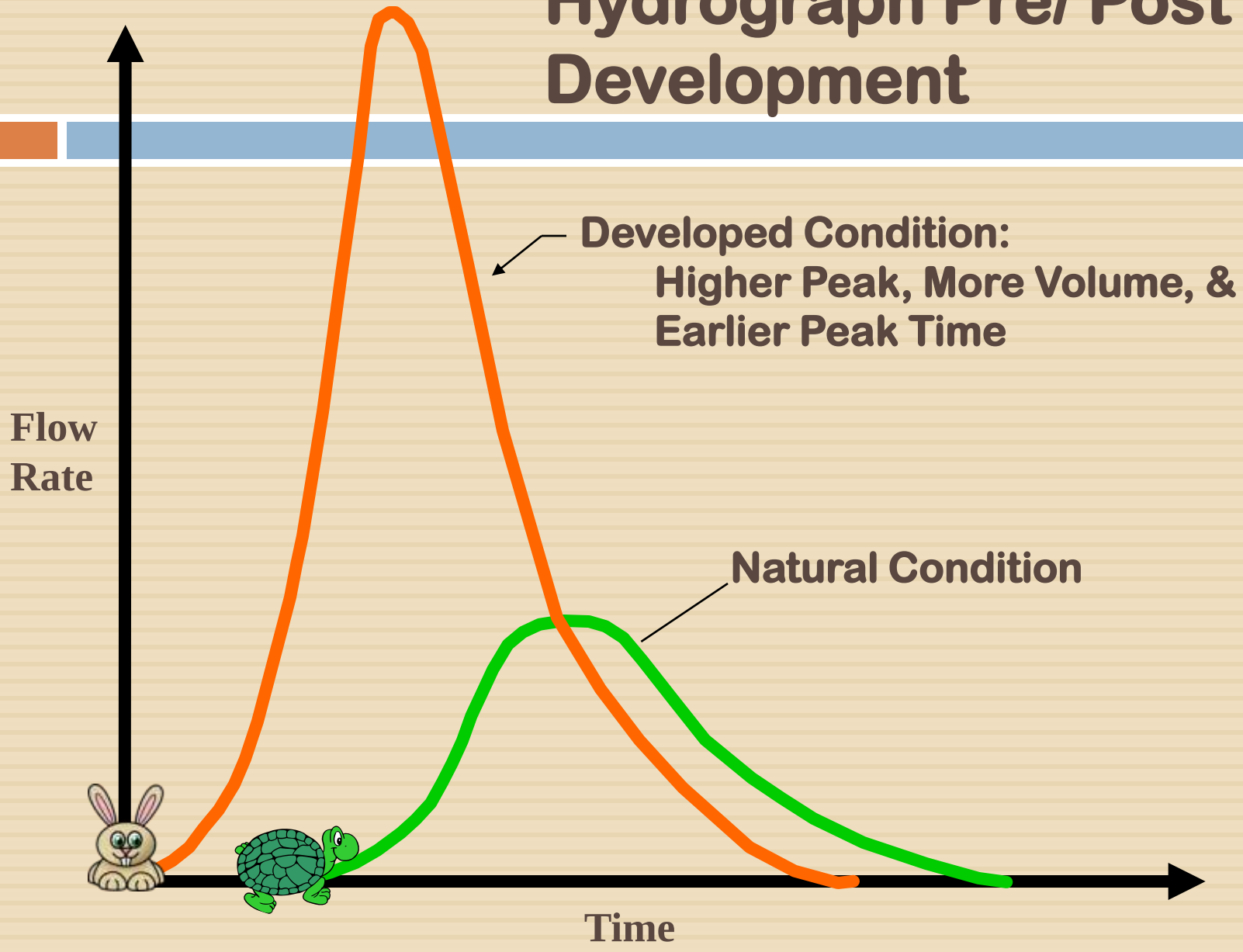
Climate modeling: current and future (24 hrs)

Return period (years)	Recent climate	mid-21st cent. Optimistic	mid-21st cent. Moderate	mid-21st cent. Pessimistic
2.5	2.5	2.84	3.3	6.86
5	3.17	3.47	4.11	8.4
7.5	3.57	3.88	4.66	9.39
10	3.86	4.19 +9%	6.56 +70%	10.13 +157%
25	4.84	5.28	6.74	12.75
50	5.67	6.22	8.31	15.03
75	6.2	6.82	9.39	16.5
100	6.59	7.27	10.23	17.59

Hydrologic Soil Groups

Hydrologic soil group	Infiltration rate (inches/hour)	Soil textures
A	1.63[a]	gravel sandy gravel silty gravels
A	0.8	sand loamy sand sandy loam
B	0.45	
B	0.3	loam, silt loam
C	0.2	Sandy clay loam
D	0.06	clay loam; silty clay loam; sandy clay; silty clay; clay

Hydrograph Pre/ Post Development



Rain that falls soaks into the soil by infiltrating…


…where it flows underground into our lakes, streams and wetlands

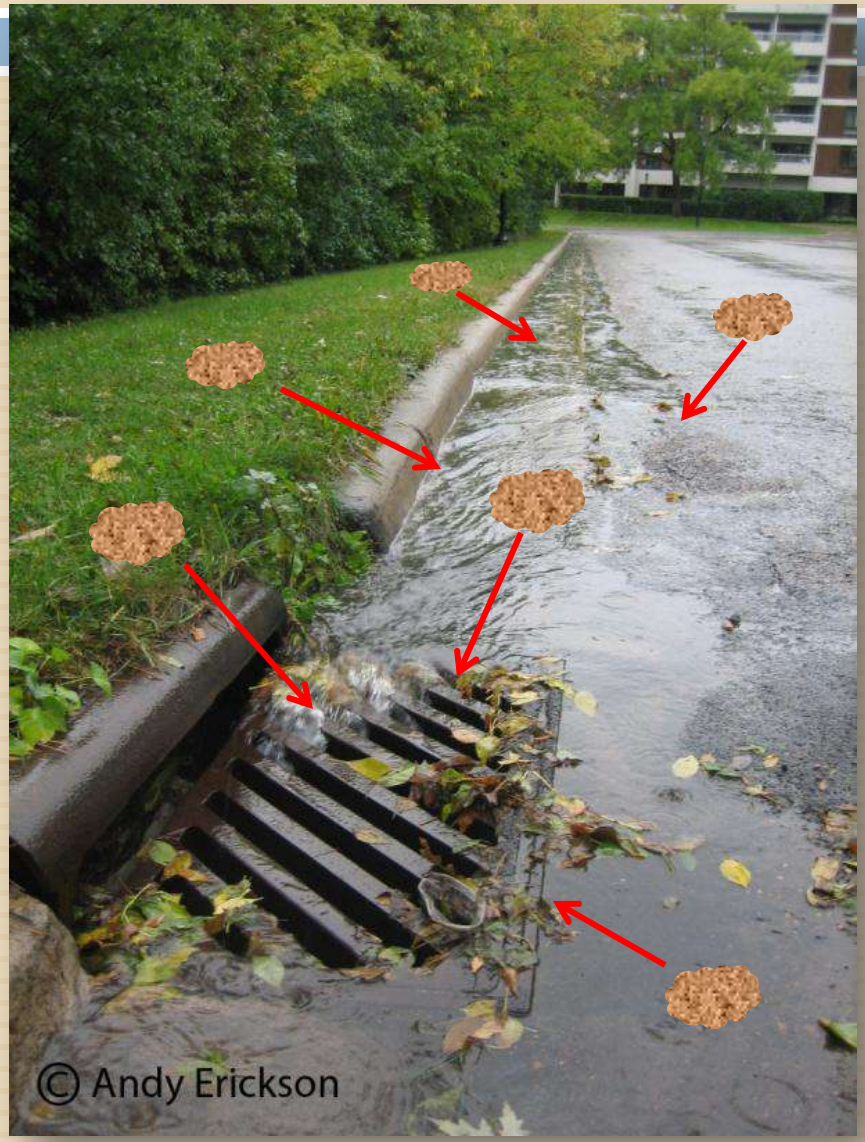
Impervious Surfaces

Rain falls on our roadways, parking lots & roofs, where it CAN'T soak into the ground…

What is in runoff?

Non-Point Source Pollution (NPS)

Pollution from a diffuse source versus a ‘point discharge’



Nutrients

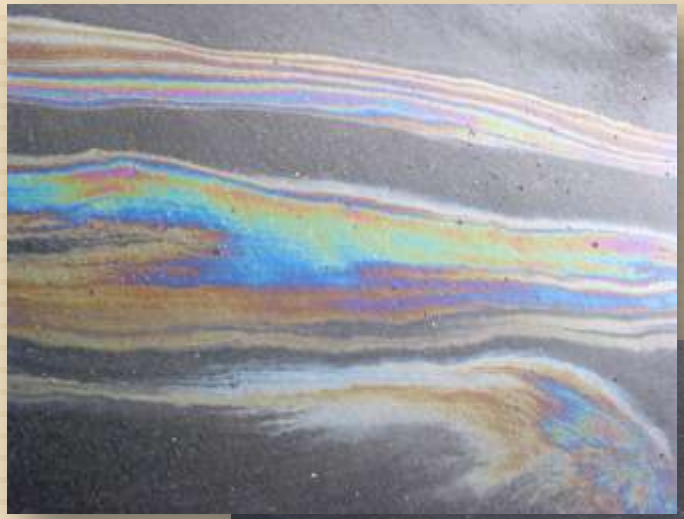
Phosphorus (P)
Nitrogen (N)

*1 lb of P supports 500 lbs of algae

Sediment

Chemicals

Oil
Gas
Pesticides



Other

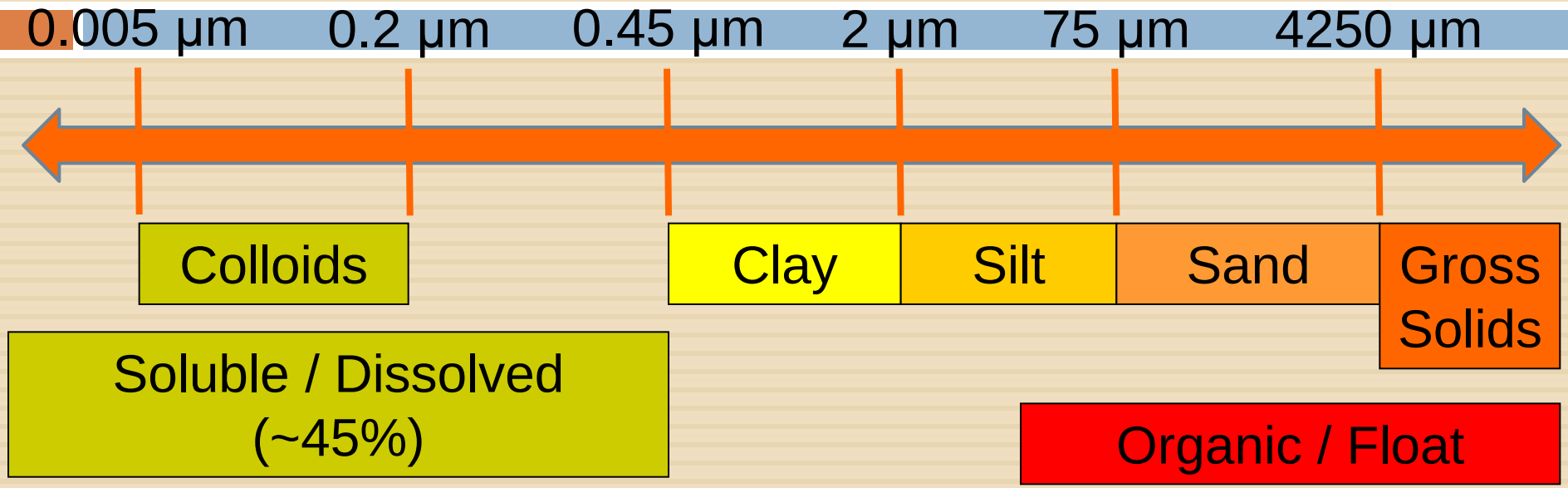
Garbage

Pathogens (bacteria)

Thermal stress (warm water)


850 billion gallons of untreated sewage spilled in
770 cities every year
NRDC

Pollutant Spectrum in Runoff



- Varies by:
  - Pollutant
  - Location in management system

Topics to cover…

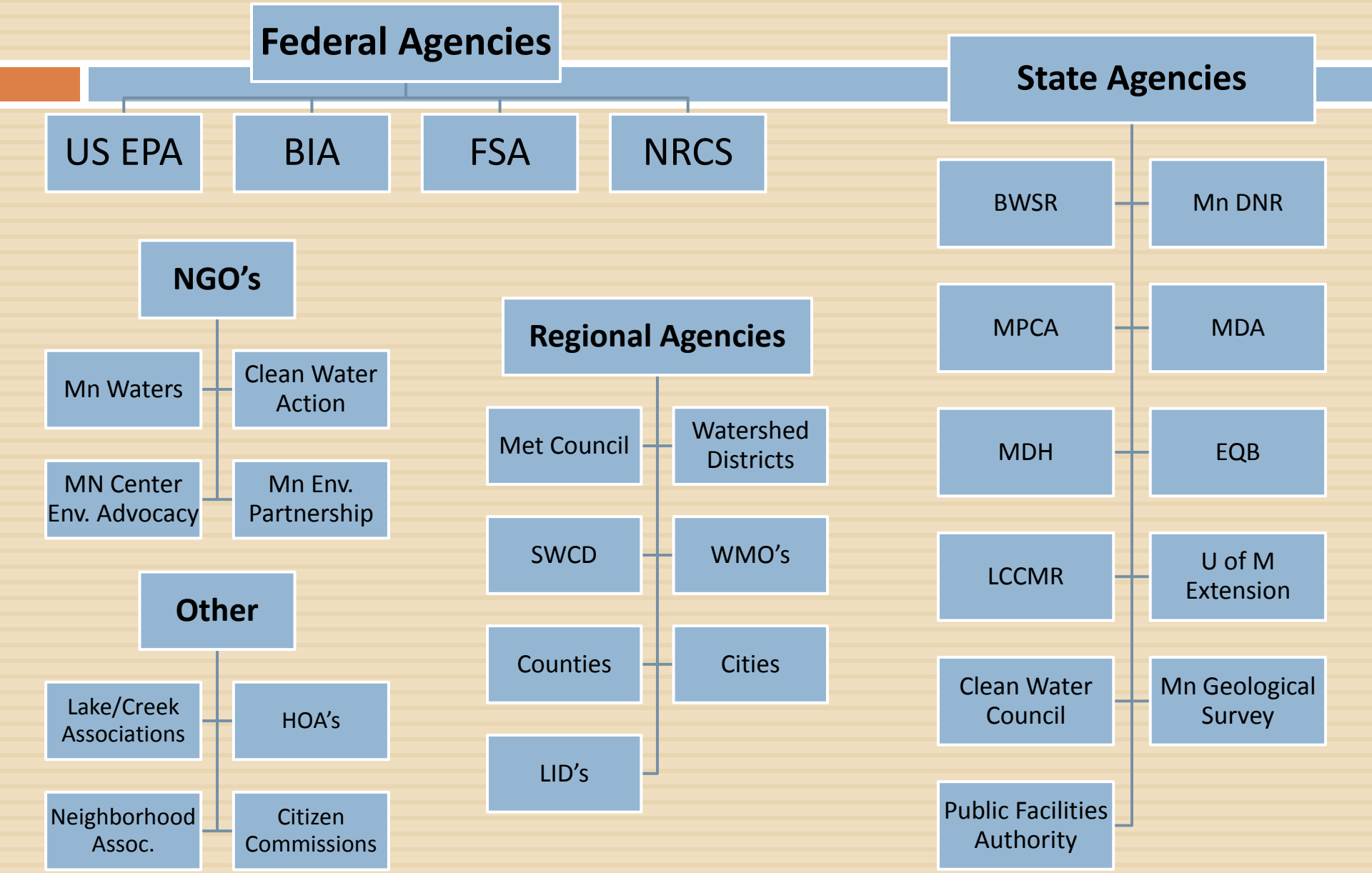
The *What*:

- Regulations
  - Clean Water Act and MS4's
  - TMDL's

Regulatory History of Stormwater Management

- 1972 Clean Water Act
- 1987 NPDES Permit (construction, industrial, municipal)
  - Phase I – large cities (Mpls, St. Paul)
  - Phase II – medium and small
  - Point-source discharges and outfalls
- Stormwater Pollution Prevention Plans (SWPPP's)
- New MS4 permit required

Water Governance in Minnesota



What is a TMDL?

~60 μg/l TP

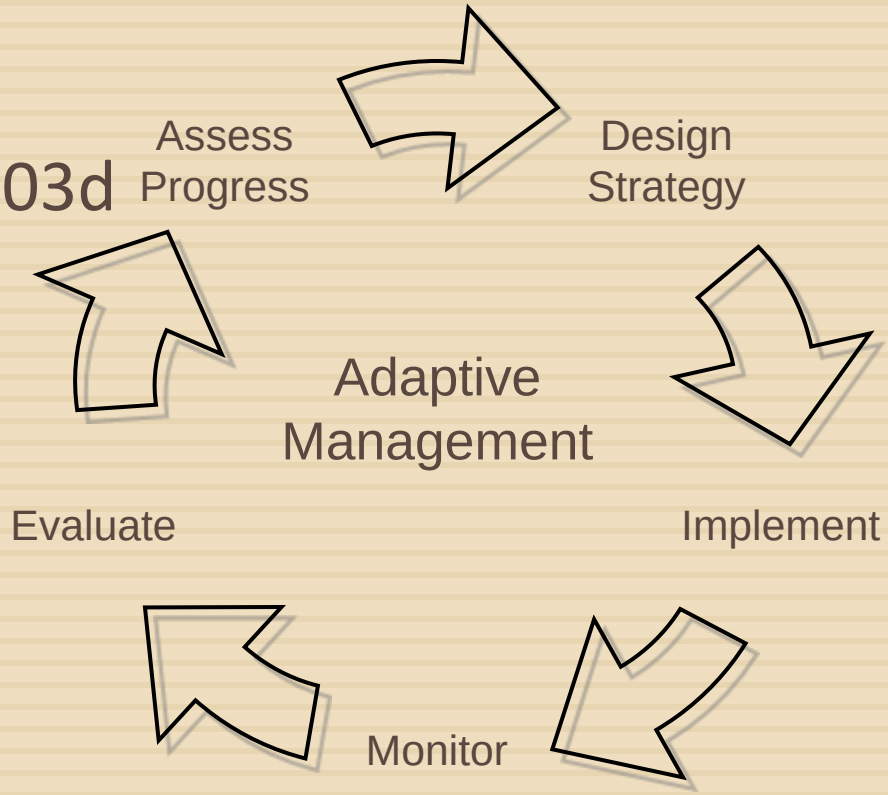
A **T**otal **M**aximum **D**aily **L**oad

a Clean Water Goal

- Required by federal Clean Water Act – Delegated to Mn Pollution Control Agency (MPCA)
- Scientific study conducted on impaired waters to determine how much a pollutant load needs to be reduced
- Purpose: "… to restore and maintain the chemical, physical, and biological integrity of the Nation's waters."

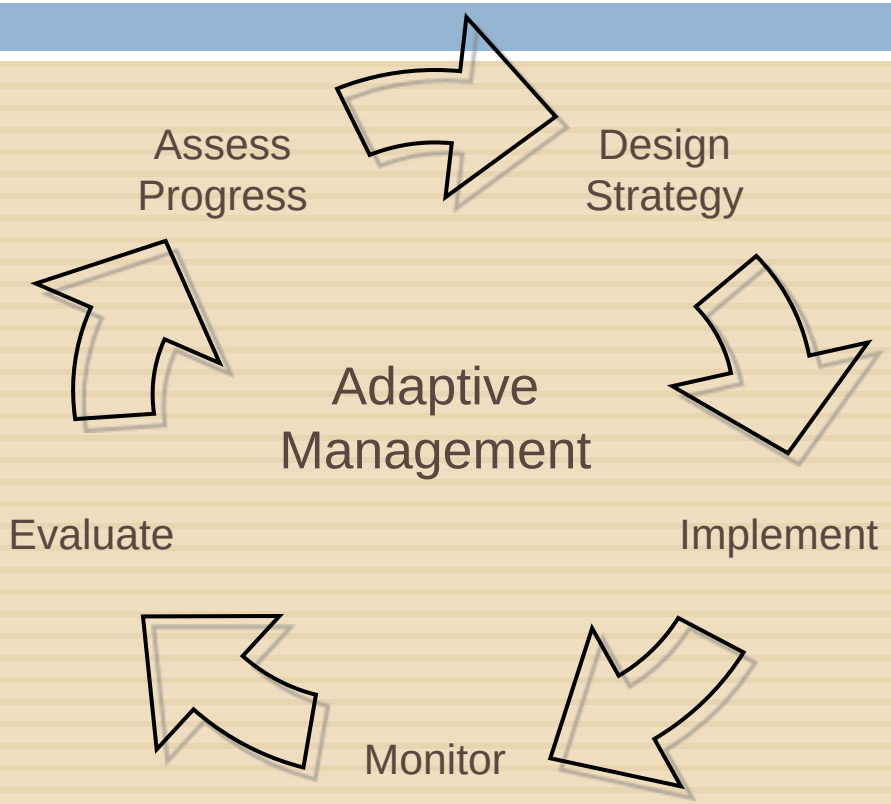
TMDL Process

- Assess water quality
- Add to Impaired Waters List (303d list)
- Conduct TMDL study:
  - Determine loading capacity
  - Identify and quantify sources
  - Determine reductions needed
  - Assign load allocations (LA)



TMDL Process

- Develop implementation plan
- Track progress



TMDL Implementation Plan - Wassermann Lake

Source	Existing Load (lbs/yr)	Target Load (lbs/yr)	Load Reduction (lbs/yr)	% Reduction
Internal Load	505	63	442	88%
Atmospheric Deposition	44	44	0	0%
Non-reg. Stormwater Runoff	55	51	4	7%
Victoria Laketown Twp	147	124	23	16%
Carver County	2.5	1.3	1.2	48%
Total	753	283	470	62%

Implementation Activity	P Load Reduction	Cost	Timeline	Partners
Install Stormwater BMPs	Low	$100,000-220,000	2010-2020	Victoria/MnDOT
Education Program	Low	--	2010-2030	MCWD, Carver County, Victoria, Laketown Twp
Marsh Lake/WL Wetland Restoration	High	$1,408,800	2010-2012	MCWD
Marsh Lake MP	Low	$20,000-40,000	2010-2012	MCWD, MPCA
Wetland Restoration	High	$400,000-600,000	2010-2030	Carver County, MCWD, Laketown Twp, Victoria
Internal Load Project	High	$231,600	2013-2018	MCWD
Shoreline Restoration	Low	$20,000-30,000	2010-2030	MCWD, Victoria, Laketown Twp
Municipal Ordinances	Med	$5000-15,000	2010	Victoria Laketown Twp

Topics to cover…

The *How*:

- Traditional Treatment (pre-1980's)
- Conservation/Smart Design (early 1980's)
- Low Impact Development (LID) (late 1990's)
- Green Infrastructure (GI) (early 2000's)
- Benefits
- Maintenance

Stormwater Design Philosophy

End of Pipe treatment – ‘NURP’ ponds

Conservation Design/Smart Design

Low Impact Development (LID)

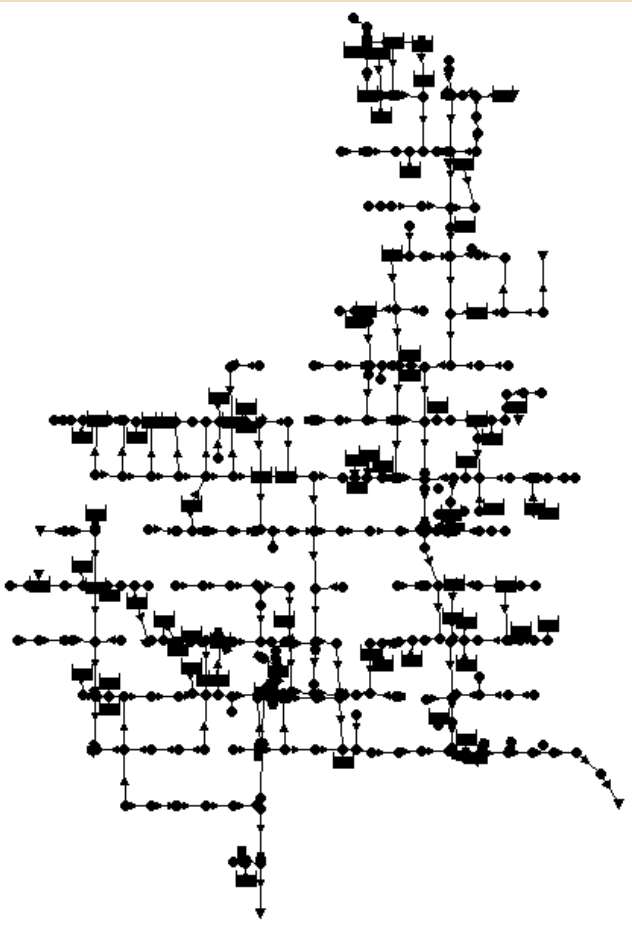
Green Infrastructure (GI)

End of Pipe Treatment

1. Rainfall

Stormwater Infrastructure

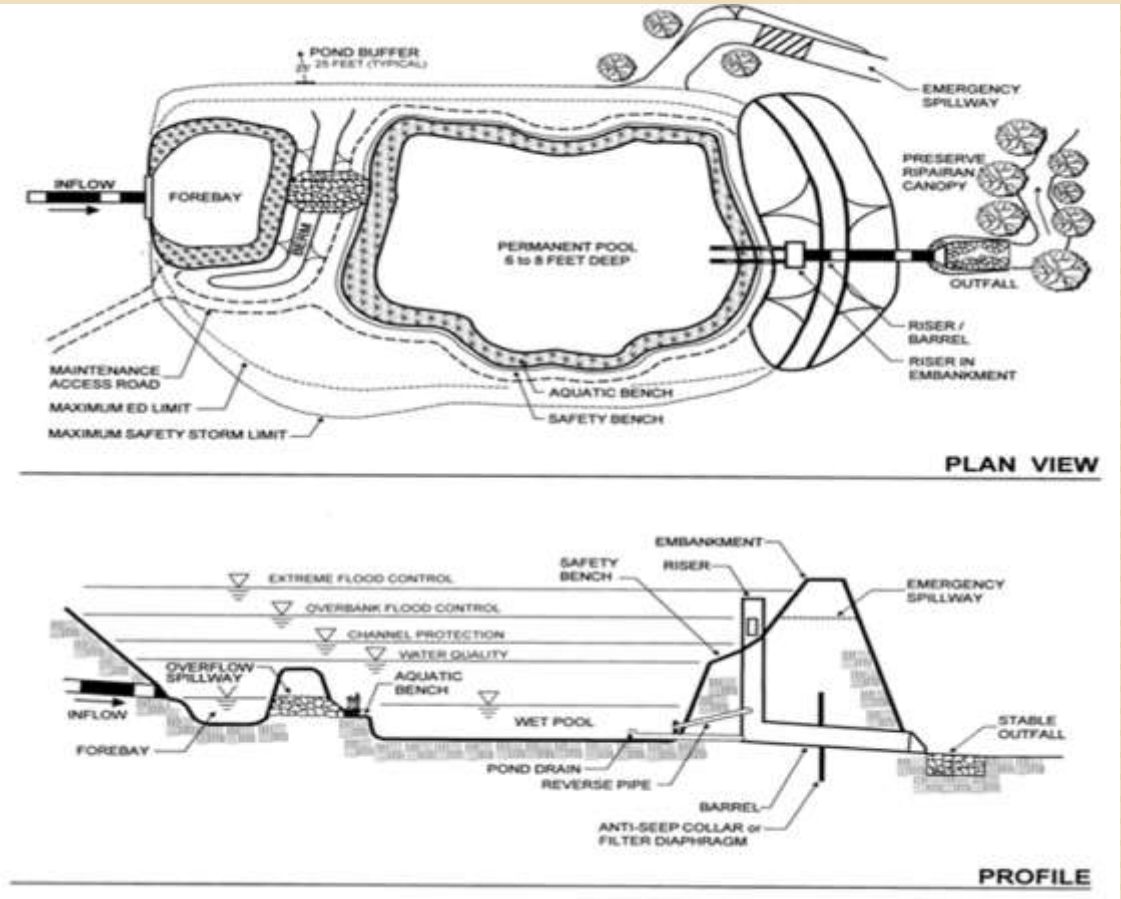
Underground pipes take runoff away from the area…



…to a place where it is captured and stored.

‘NURP’ ponds

- effective for providing runoff detention storage (Rate/volume)
- treatment is settling of particulates and their associated pollutants as stormwater runoff resides in the pond (quality)



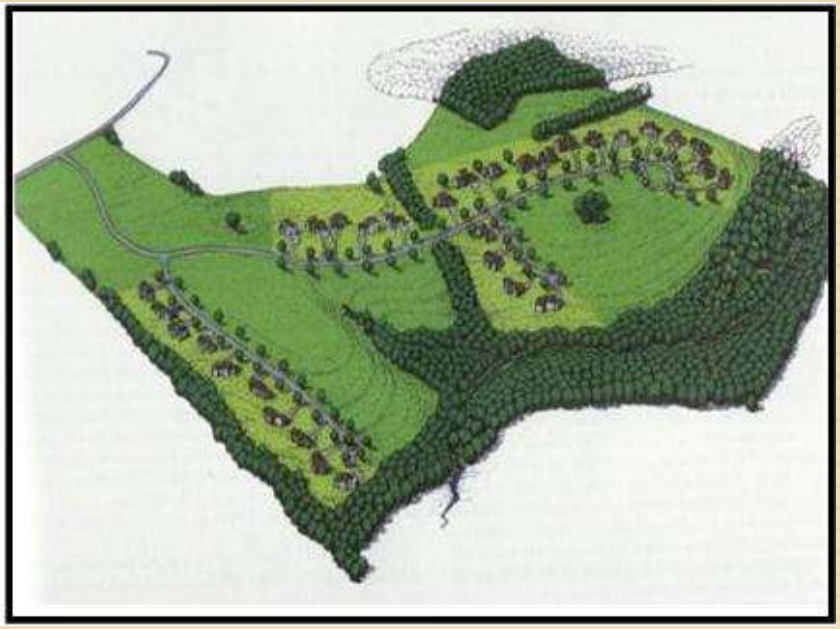
Development significantly impacts how and where water flows

Get this…

…to function like this.

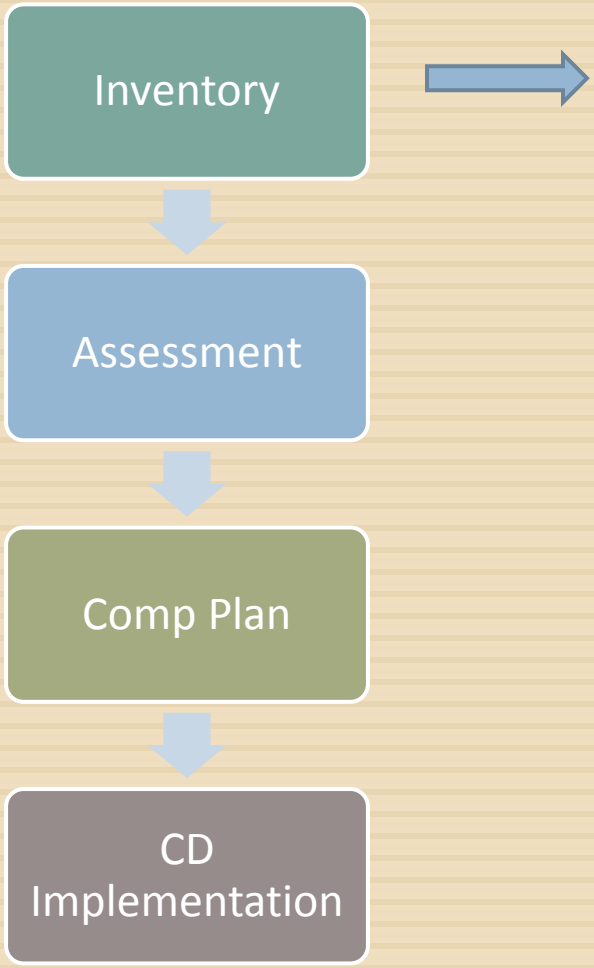
Conservation Design

1. Minimize impervious cover
2. Disconnect impervious cover
3. Protect natural areas



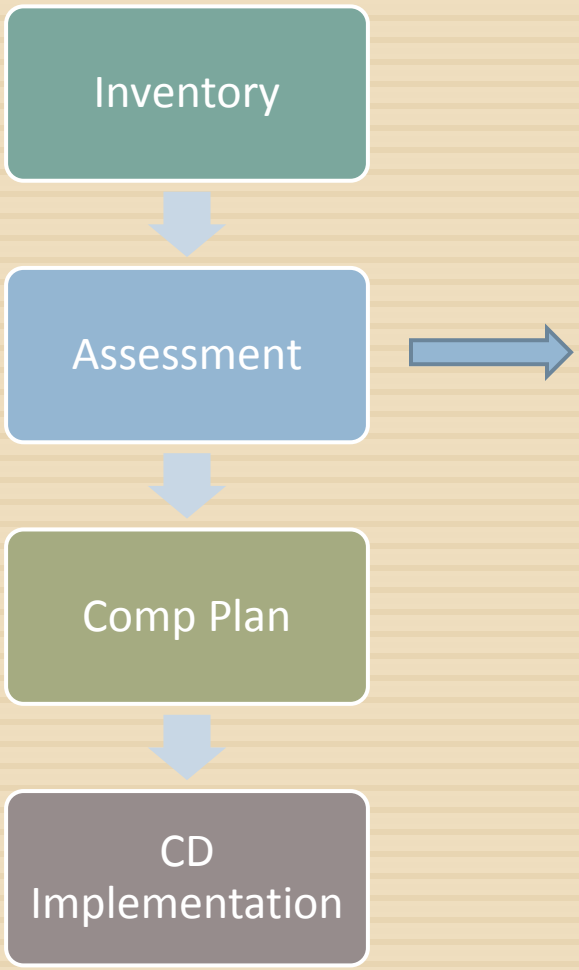
Protect natural areas, and let them work naturally…

Planning-Implementation



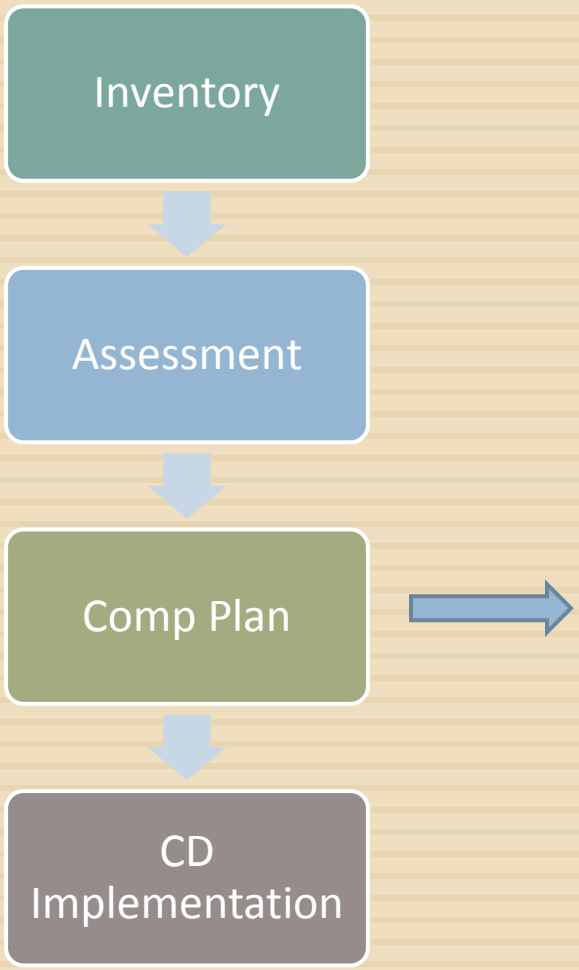
- Water bodies & quality
- Shoreline type
- Floodplains
- Plant & wildlife communities
- Soils
- Topography
- Natural areas
- Other community resources

Planning-Implementation



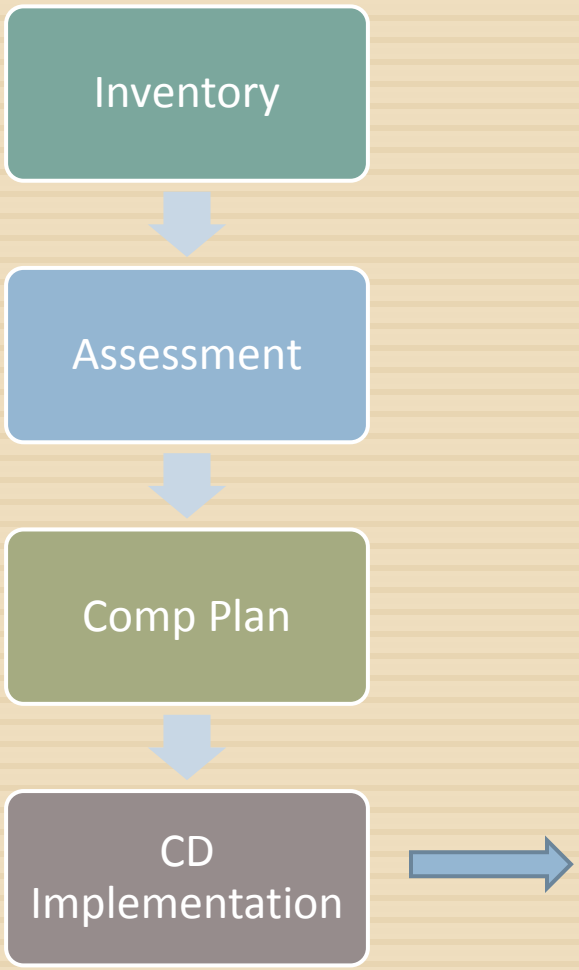
- Evaluate and prioritize resources for protection
- Considerations:
  - Regional plans & priorities
  - Watershed plans & priorities
  - Opportunities and threats to protection
  - Community values
- GIS based (simple to complex)

Planning-Implementation



- Develop goals & policies
- Zoning (conservation design)
- Other regulations (stormwater)
- Other tools
  - Land & easement acquisition
  - Park & open space development

Planning-Implementation



- Conservation Design Ordinance
  - Identify protection priorities (be specific !!!)
  - Engage community
  - Determine CD ordinance approach
  - Draft standards

Low Impact Development

"Low Impact Development (LID) is an approach to stormwater management that mimics a site's natural hydrology, and is a versatile approach that can be applied to new development, urban retrofits, and redevelopment." - EPA

History of LID

- Prince George's County, Maryland, in the mid-1980s.
- LID was pioneered to help Prince George’s County address the growing economic and environmental limitations of conventional stormwater management practices.
- LID allows for greater development potential with less environmental impacts through the use of smarter designs and advanced technologies that achieve a better balance between conservation, growth, ecosystem protection, and public health / quality of life.

Low-Impact Development Design Strategies

An Integrated Design Approach

- *Site Planning*
- *Hydrology*
- *Distributed IMP Technologies*
- *Erosion and Sediment Control*
- *Public Outreach*

Prepared by:

Prince George's County, Maryland

Department of Environmental Resources

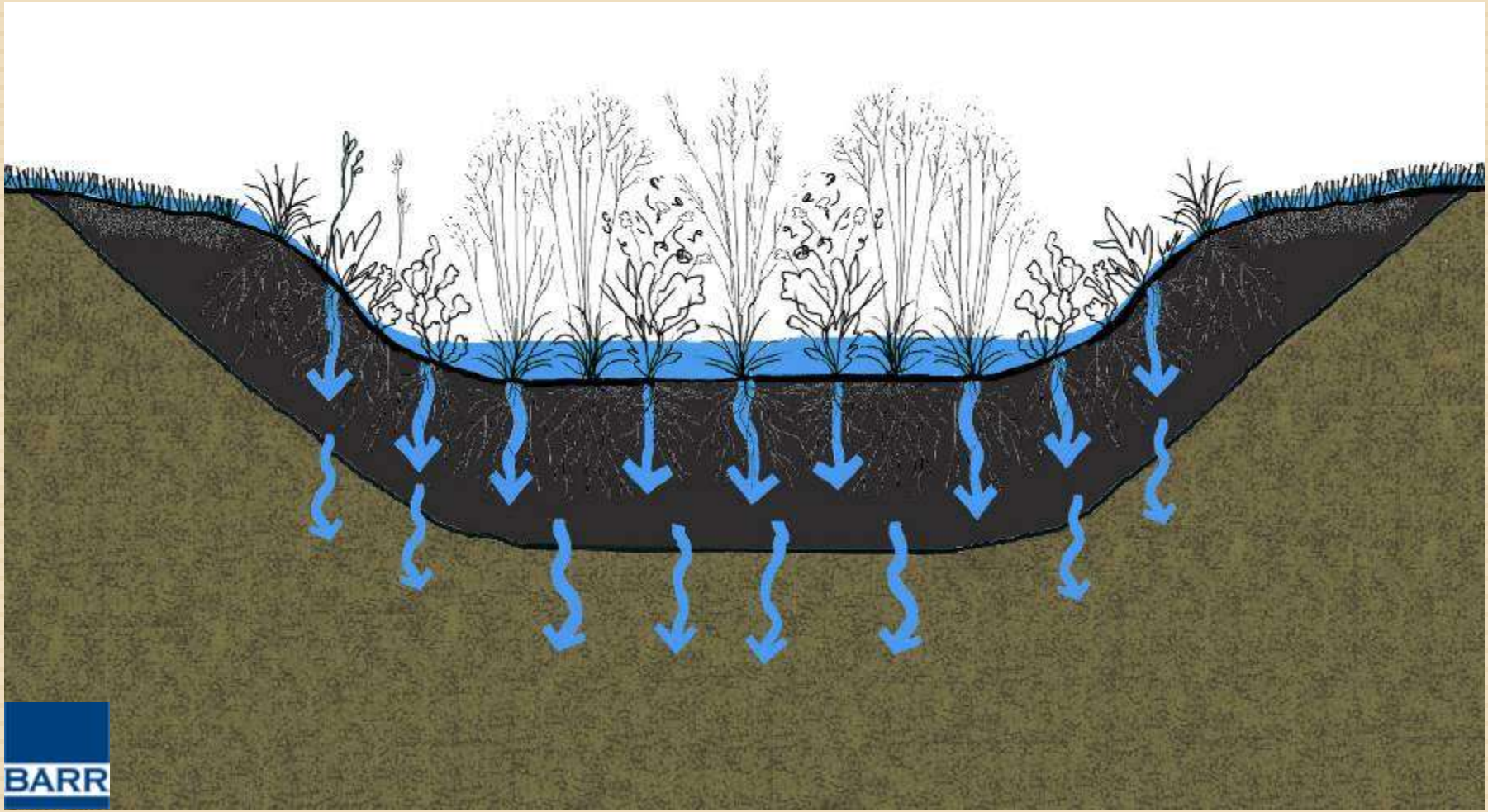
Programs and Planning Division

June 1999

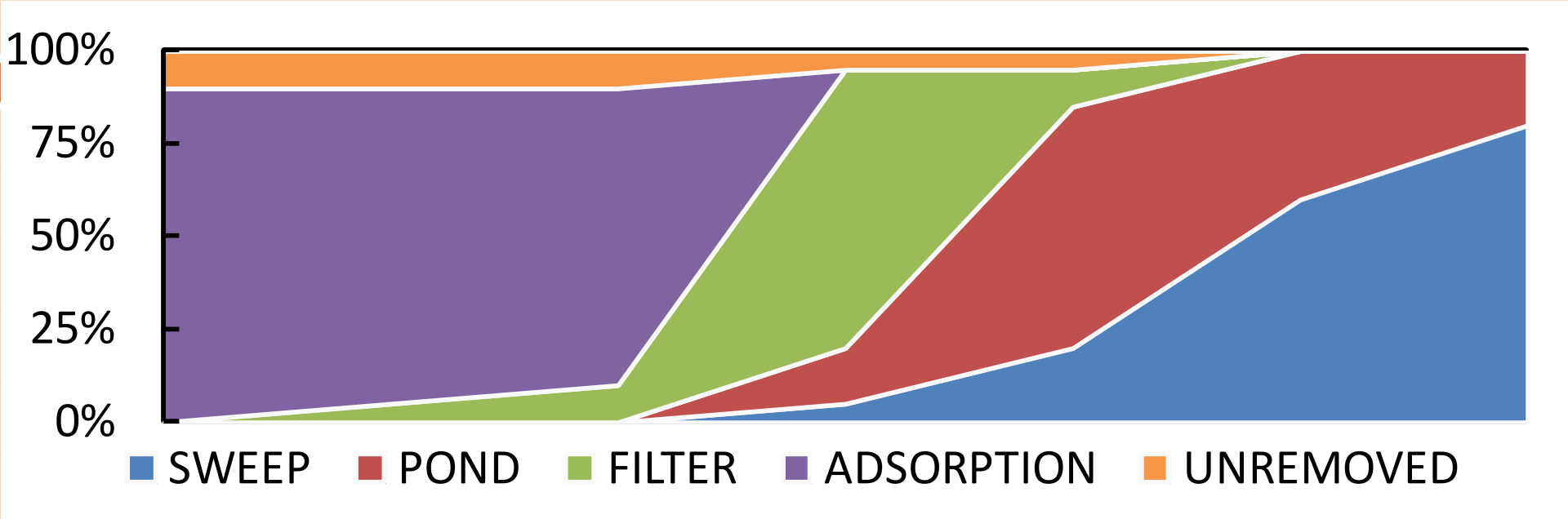
Reduce impervious surfaces = less rate, quantity, and NPS

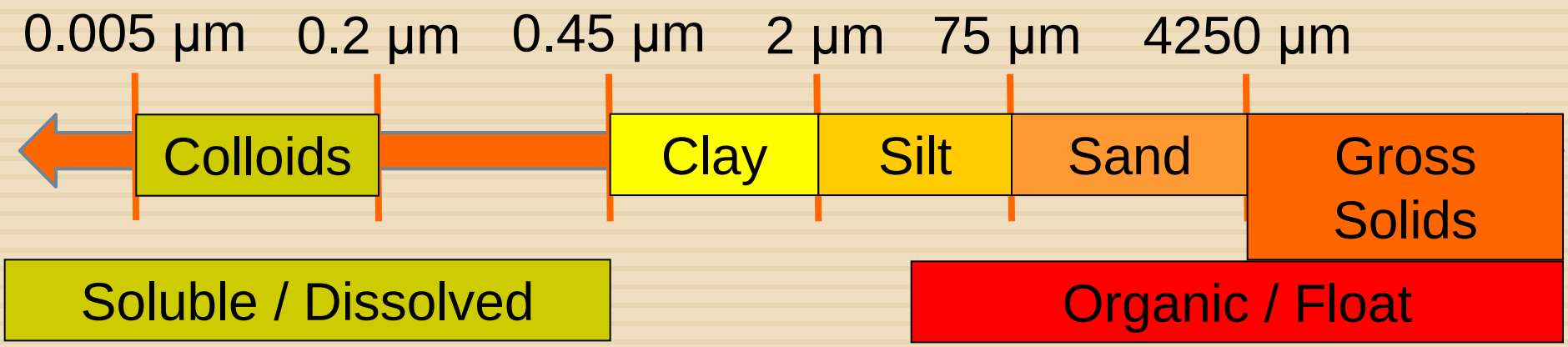
Photo by Fred Rozumalski

Keep runoff on site, and help it soak into the ground (infiltration)…



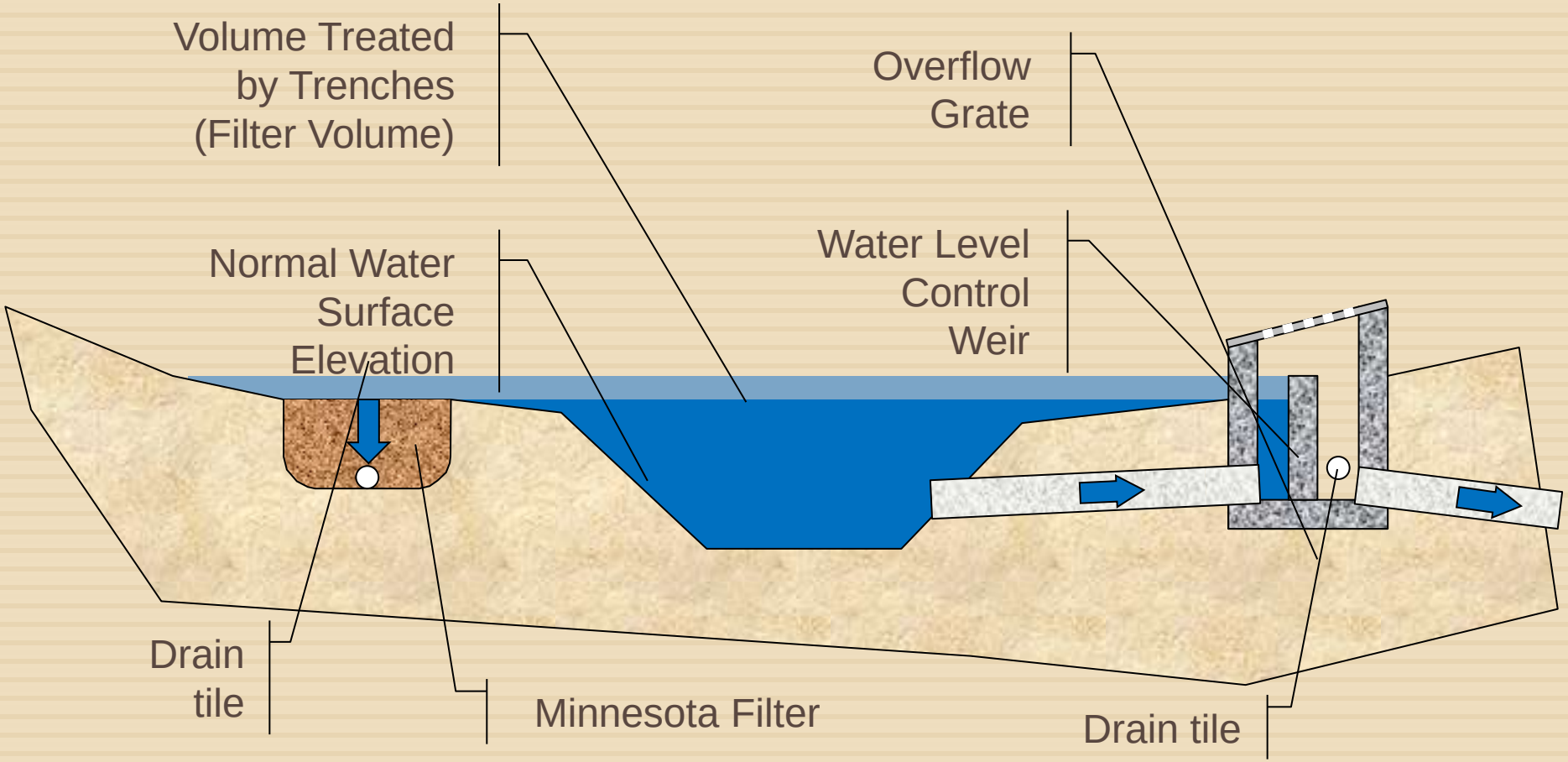
Treatment Train Approach





Andy Erickson, SAFL

Filter Trenches around wet detention ponds (Prior Lake, MN)

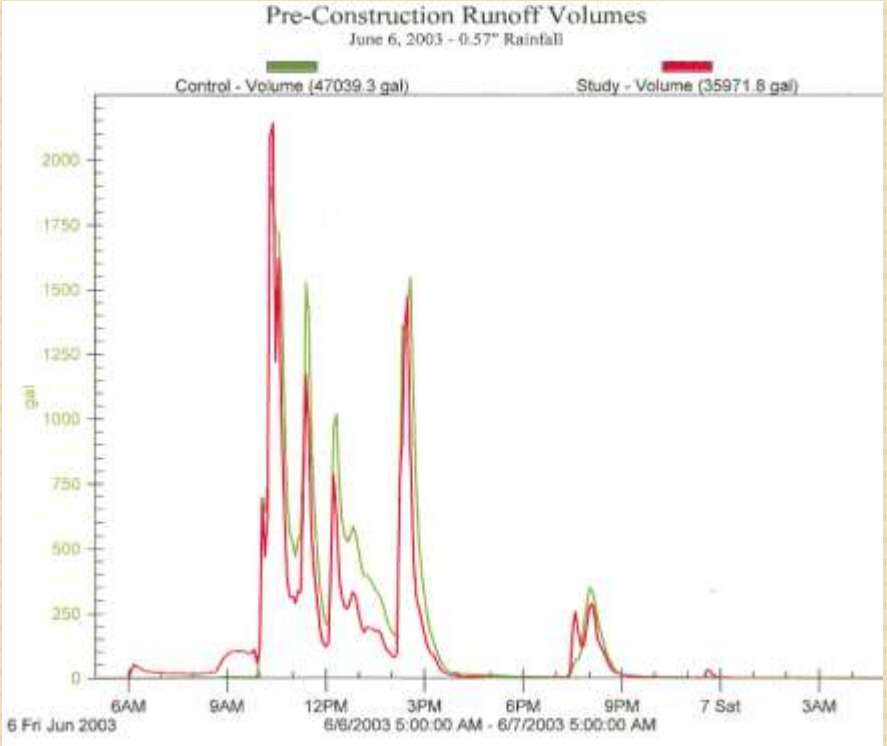


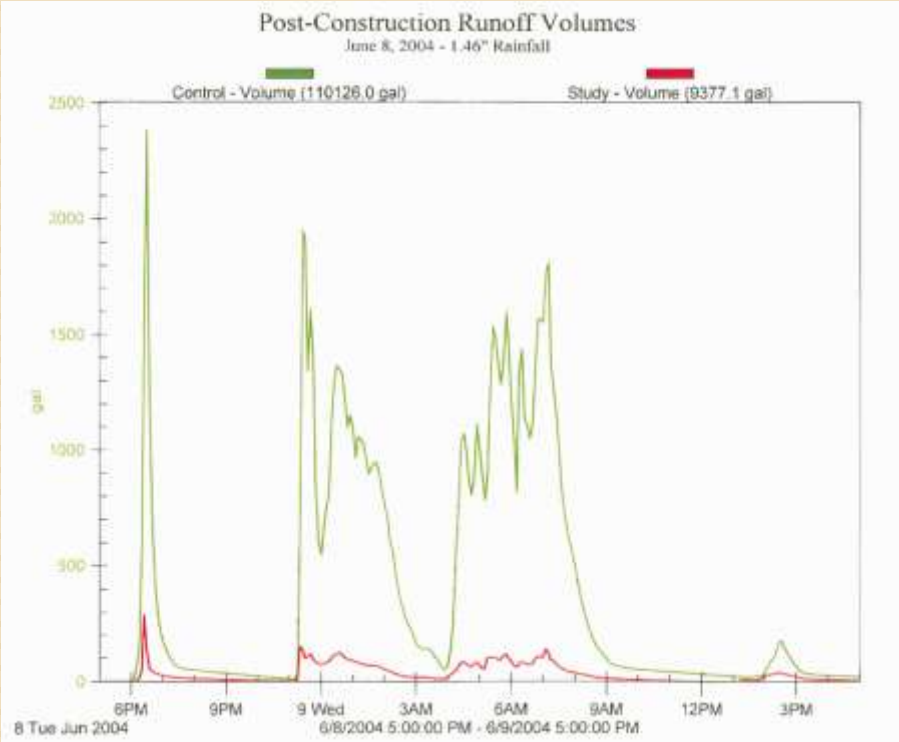
Kurt Leuthold and Fred Rozumalski, Barr Engineering Company

Rainwater Garden Layout

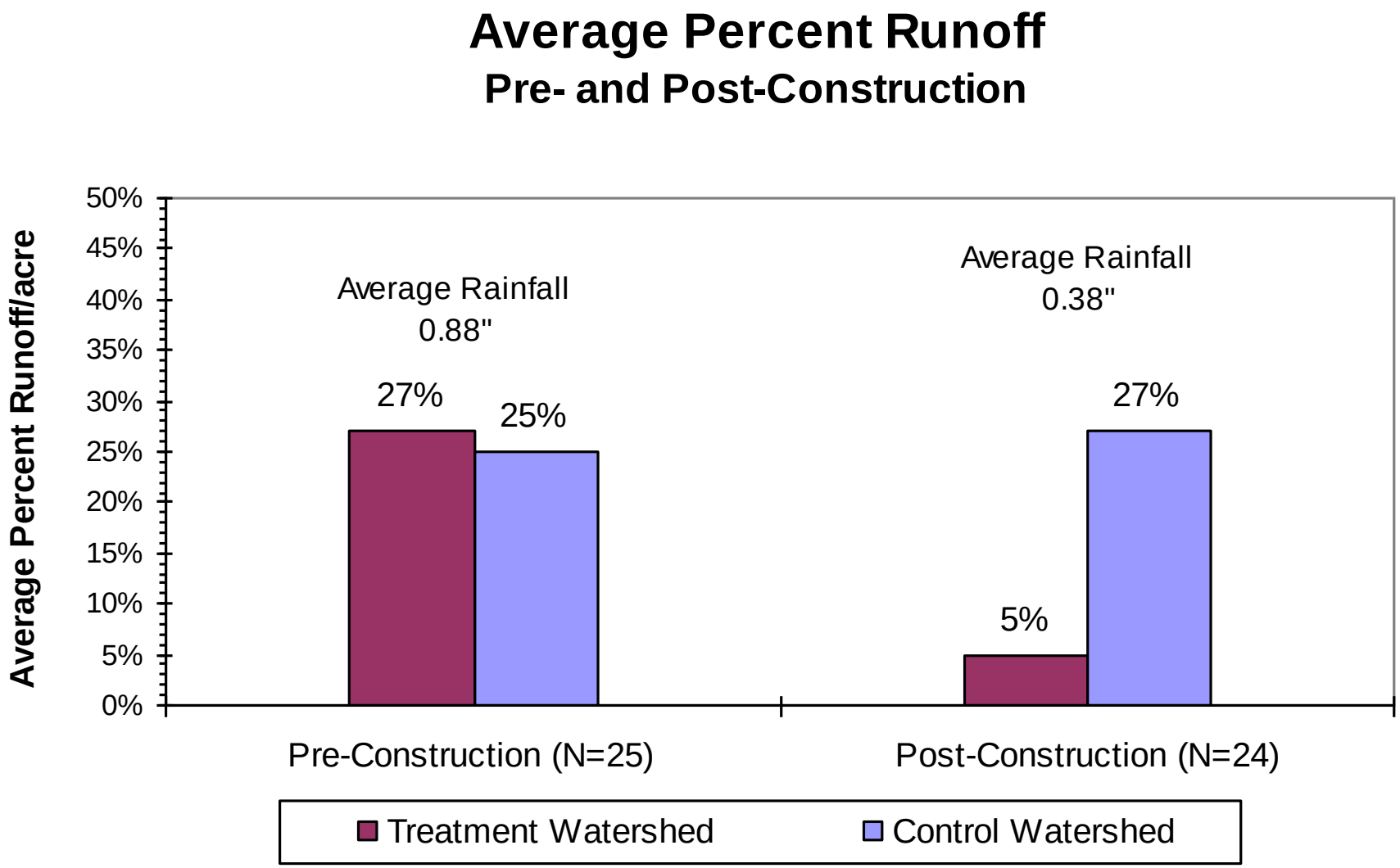
BARR

Burnsville Rain Gardens - Monitoring Results



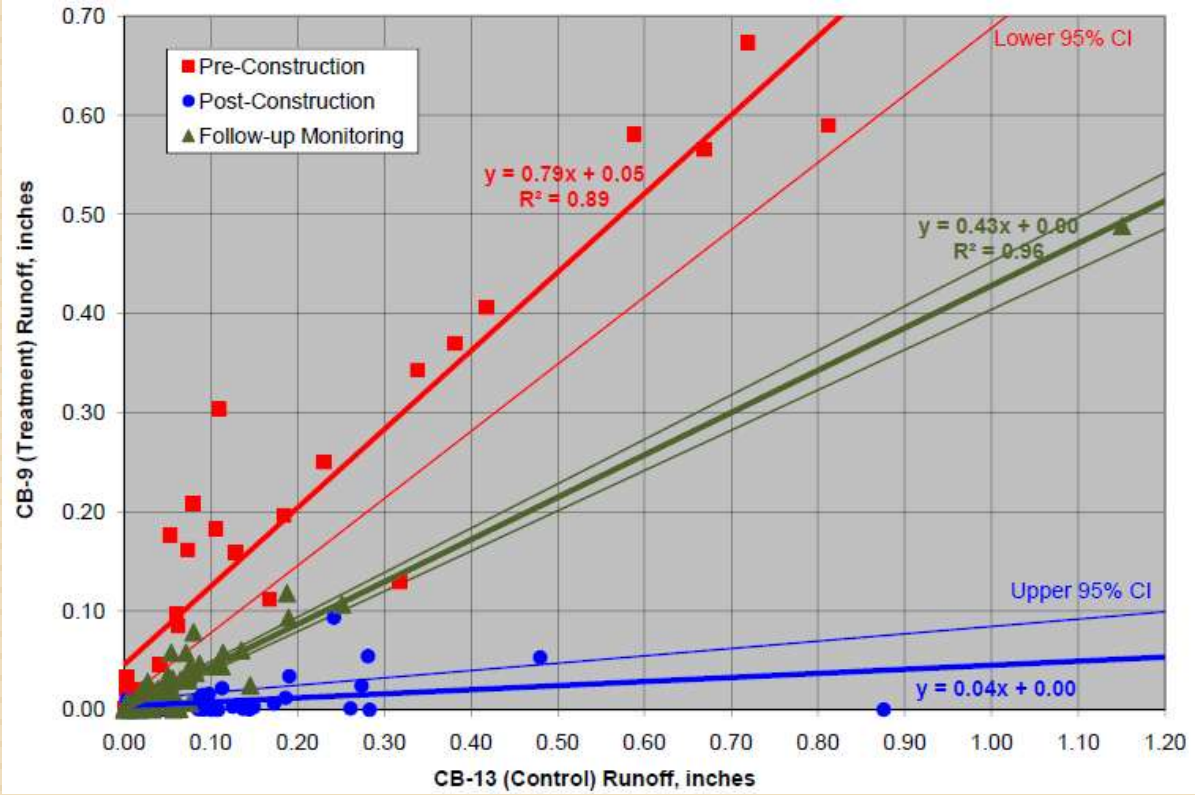


Neighborhood Runoff Post-BMP



Follow-up Monitoring - 5 years later

~56% reduction in volume of runoff



City of Burnsville


City of Burnsville
Designed by: Barr Engineering
AFTER
8. 2. 2004

What **Color** is Your Infrastructure?

Using Green Practices to Improve Water Quality and Save Money

Green Infrastructure

Green infrastructure uses *vegetation, soils, and natural processes* to manage water and create healthier urban environments.

- At the scale of a city or county, green infrastructure refers to the patchwork of natural areas that provides habitat, flood protection, cleaner air, and cleaner water.

- At the scale of a neighborhood or site, green infrastructure refers to stormwater management systems that mimic nature by soaking up and storing water.

Green Infrastructure

- native plantings
- rain gardens
- porous pavements
- green roofs
- infiltration planters
- trees and tree boxes
- rainwater harvesting

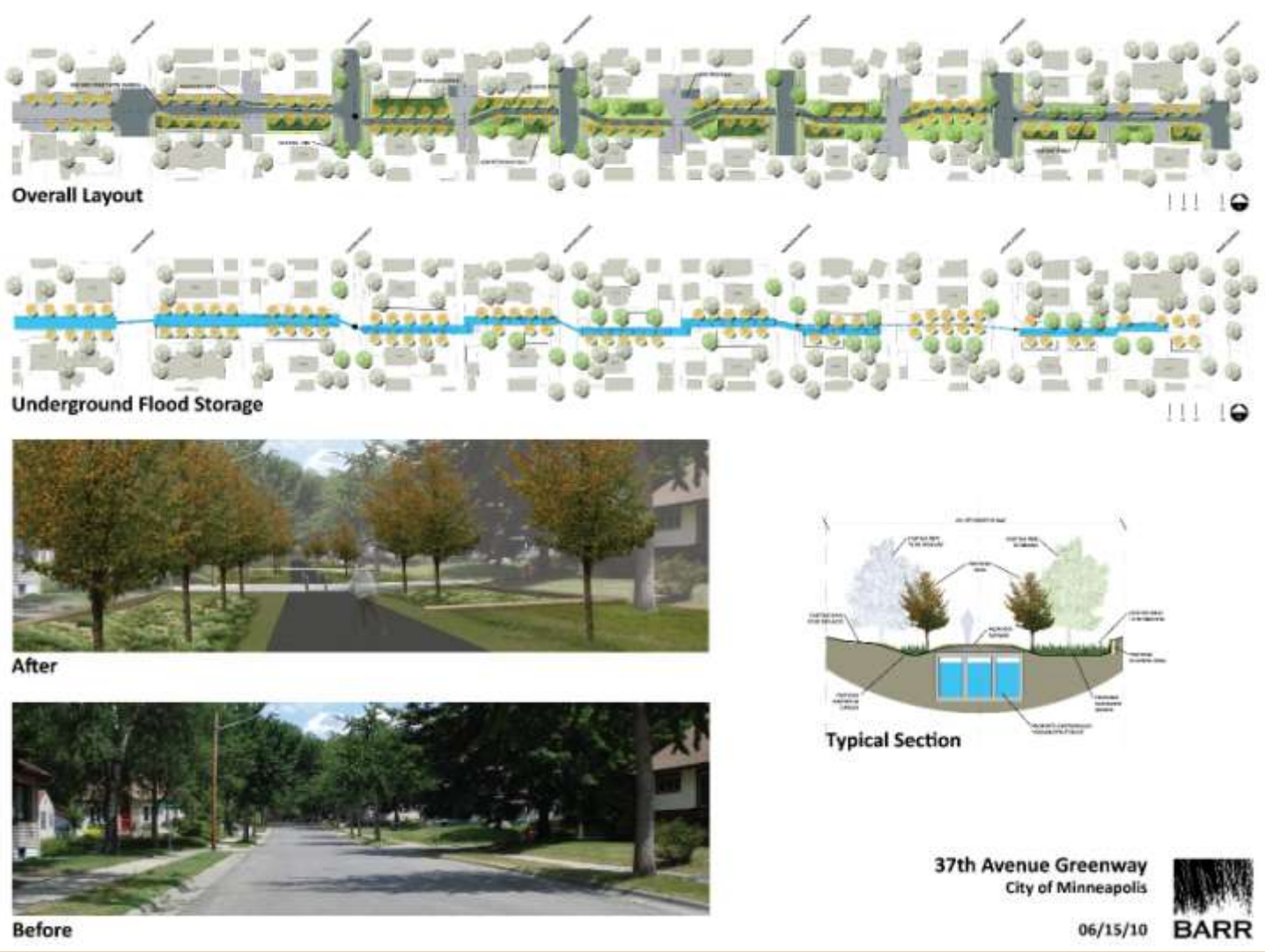
Green Infrastructure Practices

RWMWD Offices

City of Minnetonka Campus

BARR

37th Avenue Greenway - Mpls



37th Avenue Greenway - Mpls

BARR

Maplewood Mall

BARR

Green Roofs


"EXTENSIVE" VEGETATION
SOIL SUBSTRATE
SYSTEMFILTER SF
FLORADRAIN 40
MOISTURE MAT SSM45
HYDRODRAIN AL
STYROFOAM
ROOT STOP WSF 40
HYDROFLEX
MM6125-EV
SURFACE CONDITIONER
CONCRETE

‘Living Streets’

Green Infrastructure in the Shoreland Area

Green Infrastructure in the Shoreland Area


After: Biolog at Toe, Planted Buffer
Designed & Installed by:
Natural Shore Technologies

LID versus GI

LID and Green Infrastructure

"Green infrastructure" is a relatively new and flexible term, and it has been used differently in different contexts. However, for the purposes of EPA's efforts to implement the Green Infrastructure Statement of Intent (PDF), EPA intends the term "green infrastructure" to generally refer to systems and practices that use or mimic natural processes to **infiltrate**, **evapotranspirate** (the return of water to the atmosphere either through evaporation or by plants), or **reuse** stormwater or runoff on the site where it is generated. Green infrastructure can be used at a wide range of landscape scales in place of, or in addition to, more traditional stormwater control elements to support the principles of LID." – EPA


Dogs can
help, too!

Benefits and Incentives

- Environmental
  - Improved water quality
  - Improved air quality
  - Improved groundwater recharge
  - Energy savings from reduced air conditioning
  - Reduced greenhouse gas emissions
  - Reduced urban heat stress
  - Reduced sewer overflows
- Economic
  - Reduced construction costs with grey infrastructure
- Social
  - Improved aesthetics
  - More urban greenways
  - Increased public education
  - Reduced flash flooding
  - Green jobs
  - Increase in economic development

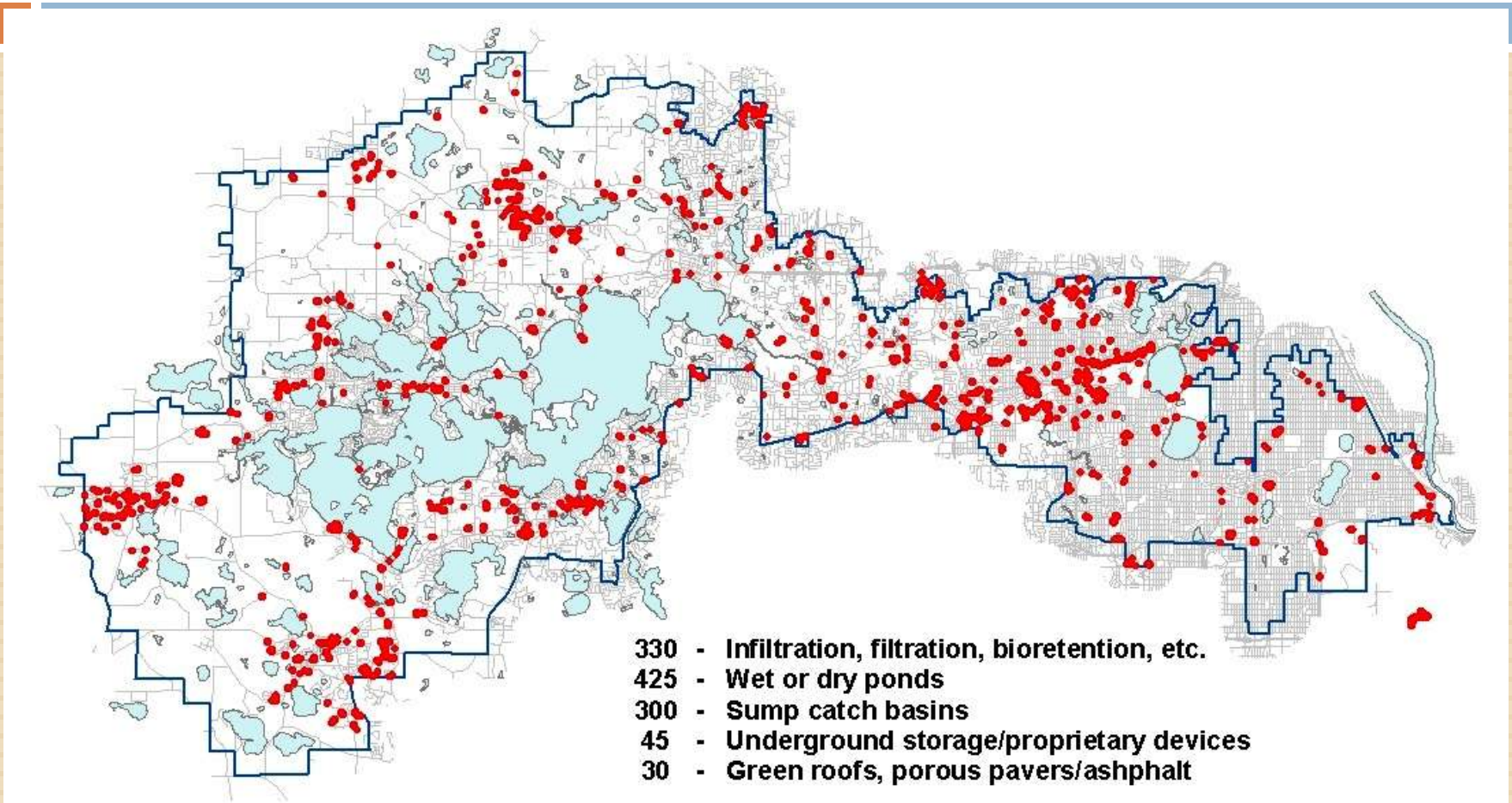
Tools and Resources

- Minnesota Stormwater Manual – MPCA website
- Low Impact Development Center
- US EPA
- Valuation of LID and Green Infrastructure
  - The Green Edge: How Commercial Property Investment in Green Infrastructure Creates Value http://www.nrdc.org/water/commercial-value-green-infrastructure.asp
  - Triple Bottom Line, Ohio
  - ISI Envision http://www.sustainableinfrastructure.org/
  - ASLA SITES Initiative http://www.asla.org/ContentDetail.aspx?id=25064
  - 2030 Pallette http://www.2030palette.org/
  - ITree Eco http://www.itreetools.org/eco/
  - Socio-economics modeling https://implan.com/
  - Tools to measure success in achieving social goals http://nextcity.org/topic/civic-tech

Stormwater BMP's

Maintenance, Maintenance, Maintenance!

BMPs in the MCWD



Performance longevity of stormwater BMP's is dependent on maintenance actions.

NO Maintenance = NO Operation

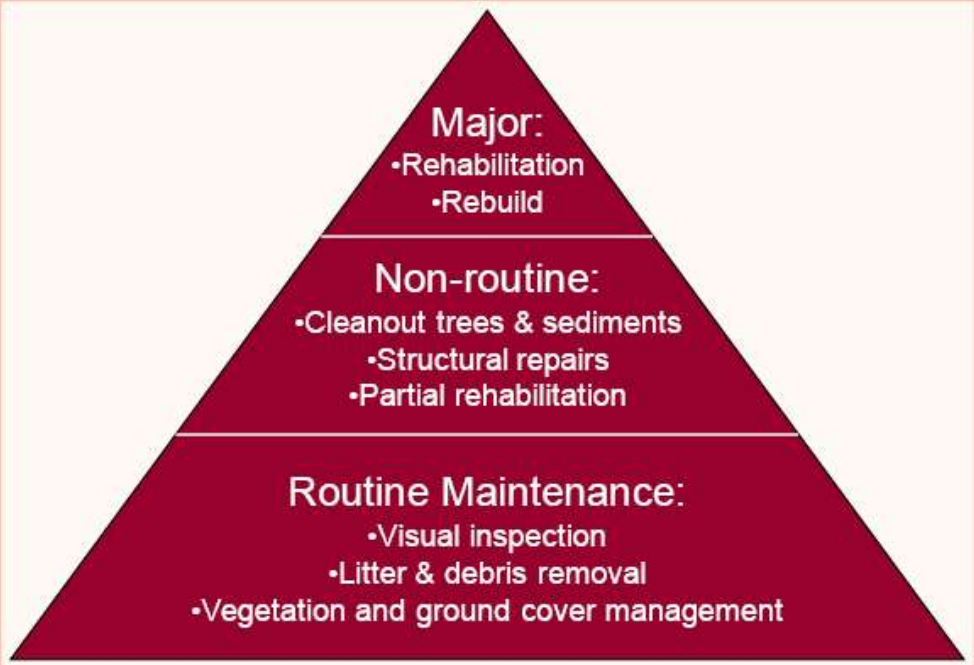
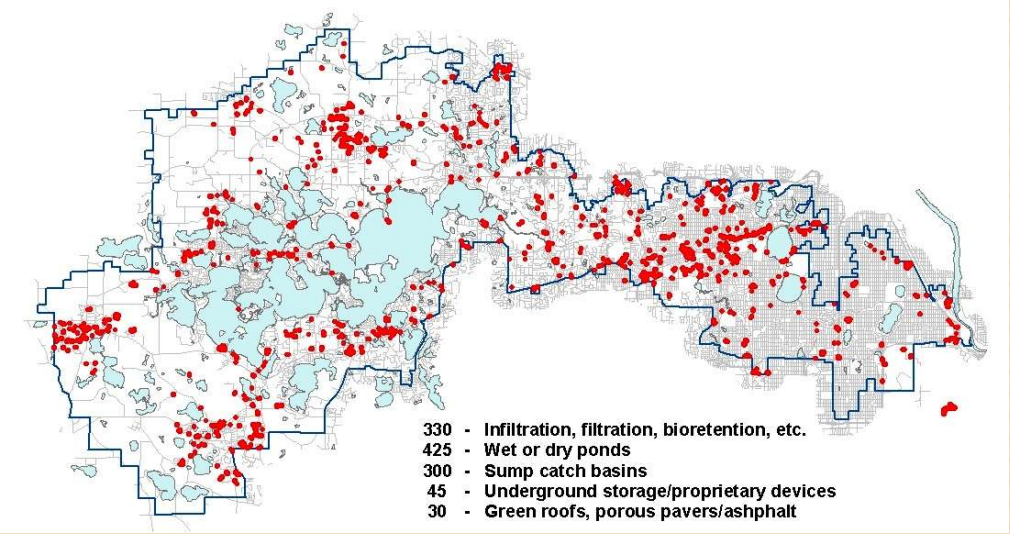


Figure 3.4: Levels of Maintenance for Stormwater Treatment Practices.

Issues to Consider

- Costs – can be considerable and can change
- Lack of awareness – what to do and when
- Lack of resources
- Who's responsible?
  - Cities
  - Watersheds
  - Counties
  - Developers
  - Private Landowners

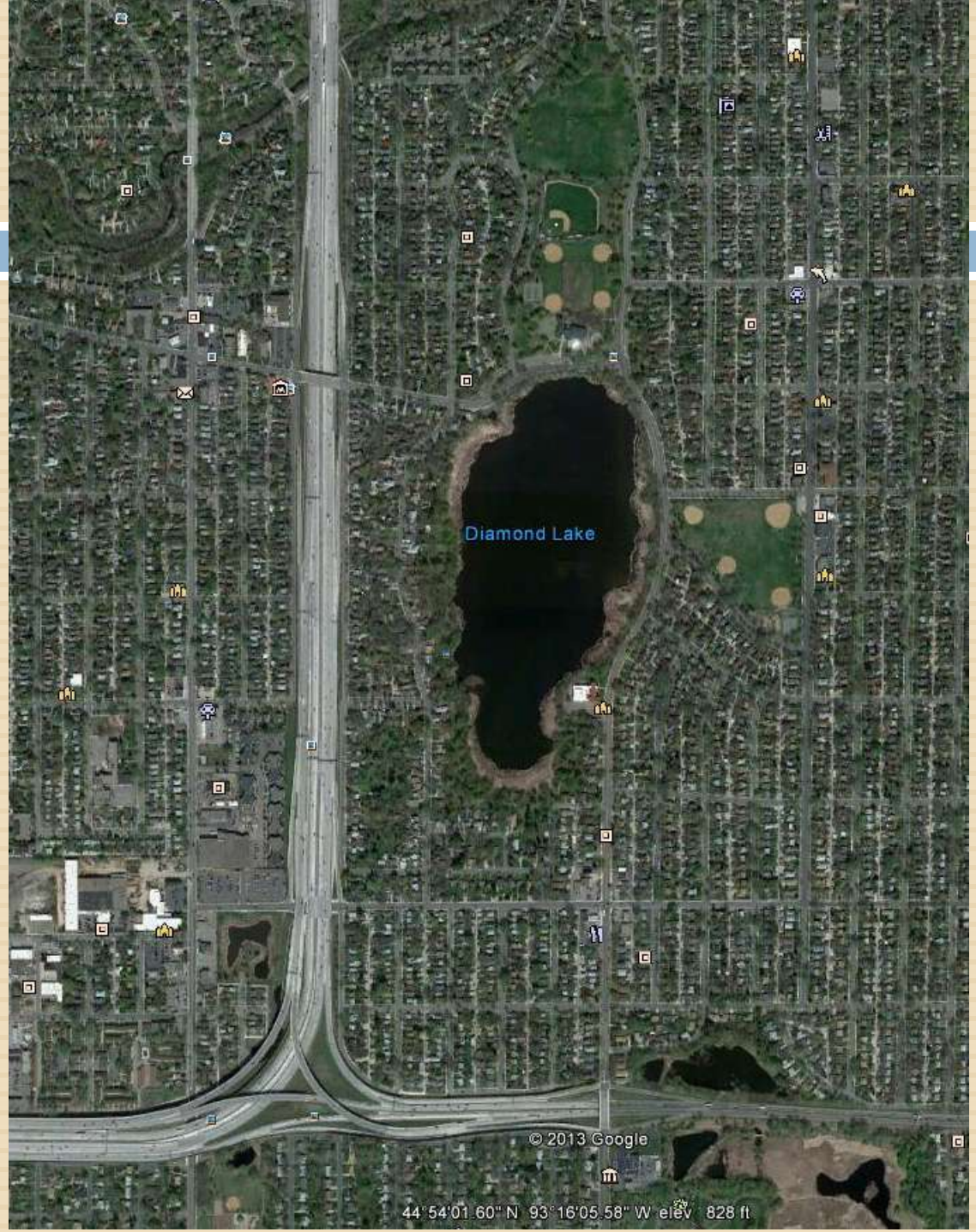


Addressing Maintenance

- Regulatory authority
  - MS4 permits
  - Maintenance agreements
  - Inspection requirements
- Education
  - Training
  - Outreach

go blue!

BLUE COMMUNITY MAKEOVER™


Diamond Lake
© 2013 Google
44°54'01.60" N 93°16'05.58" W elev 828 ft

Connelly – permeable paver driveway


Larsen - Raingardens

4 Trees

25 Raingardens

14 Permeable Pavements

22 Rain Barrels

3 RainXchanges

34 Households

1,617 Volunteer Hours

1.5 million gallons/yr

3.3 lbs P/yr

$224,224 Clean Water Funds

Channel Road

2008

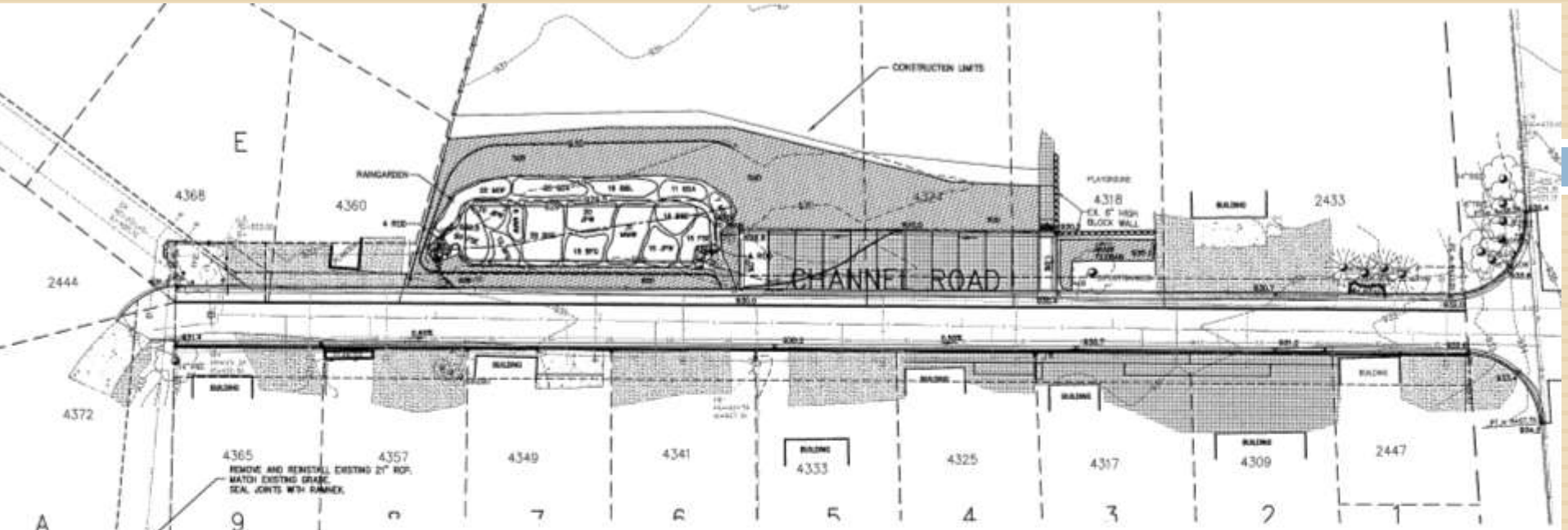
Existing conditions
- 18.5’ road, no curb
- Residential to south and west
- Interlachen Road to east
- Wilkes Park to north

2009

Road Reconstruction
- 20’ wide road, curb
- + 940 sq ft impervious cover

- Raingarden in Wilkes Park
- 5.08 ac tributary
- C/D soils
- 70% TP removal
- No draintile

Kurt Leuthold and Fred Rozumalski, Barr Engineering Company



RAIN GARDEN PLANT LIST

CODE	QTY	COMMON NAME/LATIN NAME	SIZE	ROOT	REMARKS
BBL	18	BIG BLUESTEM Andropogon Gerardi	PLUG	SEEDLING	PLANT 18" O.C. BASE
MOF	27	MONKEY FLOWER Allegheny Monkey Flower	PLUG	SEEDLING	PLANT 18" O.C. BASE
GDA	31	GOLDEN ALEXANDERS Zizia Aurea	PLUG	SEEDLING	PLANT 18" O.C. BASE
BFG	30	BLUEFLAG Iris versicolor	PLUG	SEEDLING	PLANT 18" O.C. BASE
JPW	46	JOE-PYE-WEED Eupatorium Maculatum	PLUG	SEEDLING	PLANT 18" O.C. BASE
MWW	39	MARSH MILKWEED Asclepias Incarnata	PLUG	SEEDLING	PLANT 18" O.C. BASE
FSE	40	FOX SEDGE Carex Vulpinoidea	PLUG	SEEDLING	PLANT 18" O.C. BASE
BSE	54	BUTTLEBRUSH SEDGE Carex Comosa	PLUG	SEEDLING	PLANT 18" O.C. BASE
RSD	8	RED-OSIER DOGWOOD Cornus sericea	18" HT.	#2 CONT.	PLANT 5'-0" O.C. BASE

QUANTITIES SHOWN IN THE PLANTING SCHEDULE ARE FOR THE CONTRACTOR'S CONVENIENCE. CONTRACTOR TO VERIFY QUANTITIES SHOWN ON THE PLAN.

PLANTING NOTES

1. ALL PLANTS MUST BE HEALTHY, VIGOROUS MATERIAL, FREE OF PESTS AND DISEASE AND BE CONTAINER GROWN OR BALED AND BURLAPPED AS INDICATED IN THE LANDSCAPE LEGEND.

2. ALL TREES MUST BE STRAIGHT TRUNKED AND FULL HEADED AND MEET ALL REQUIREMENTS SPECIFIED.

3. THE LANDSCAPE ARCHITECT RESERVES THE RIGHT TO REJECT ANY PLANTS WHICH ARE DEEMED UNSATISFACTORY BEFORE, DURING, OR AFTER INSTALLATION.

4. NO SUBSTITUTIONS OF PLANT MATERIAL SHALL BE ACCEPTED UNLESS APPROVED IN WRITING BY THE LANDSCAPE ARCHITECT.

5. ALL PLANTING STOCK SHALL CONFORM TO THE "AMERICAN STANDARD FOR NURSERY STOCK," ANSI-Z60, LATEST EDITION, OF THE AMERICAN ASSOCIATION OF NURSERYMEN, INC. AND SHALL CONSTITUTE MINIMUM QUALITY REQUIREMENTS FOR PLANT MATERIALS.

6. EXISTING TREES AND SHRUBS TO REMAIN SHALL BE PROTECTED TO THE DRIP LINE FROM ALL CONSTRUCTION TRAFFIC, STORAGE OF MATERIALS ETC. WITH 4' HT. ORANGE PLASTIC SAFETY FENCING ADEQUATELY SUPPORTED BY STEEL FENCE POSTS 6' O.C. MAXIMUM SPACING.

7. ALL PLANT MATERIAL QUANTITIES, SHAPES OF BEDS ARE LOCATIONS SHOWN ARE APPROXIMATE. CONTRACTOR SHALL BE RESPONSIBLE FOR COMPLETE COVERAGE OF ALL PLANTING BEDS AT SPACING SHOWN AND ADJUSTED TO CONFORM TO THE EXACT CONDITIONS OF THE SITE. THE LANDSCAPE ARCHITECT SHALL APPROVE THE STAKING LOCATION OF ALL PLANT MATERIALS PRIOR TO INSTALLATION.

8. ALL TREES MUST BE PLANTED, MULCHED, AND STAKED AS SHOWN IN THE DETAILS.

9. ALL PLANTING AREAS MUST BE COMPLETELY MULCHED AS INDICATED.

11. USE ANTI-DESICCANT (WILTPRUF OR APPROVED EQUAL) ON DECIDUOUS PLANTS MOVED IN LEAF AND FOR EVERGREENS MOVED ANYTIME. APPLY AS PER MANUFACTURER'S INSTRUCTION. ALL EVERGREENS SHALL BE SPRAYED IN THE LATE FALL FOR WINTER PROTECTION DURING WARRANTY PERIOD.

18. PLANTING SOIL FOR TREES, SHRUBS AND GROUND COVERS: FRIABLE PRAIRIE LOAM CONTAINING A LIBERAL AMOUNT OF HUMUS AND CAPABLE OF SUSTAINING VIGOROUS PLANT GROWTH. IT SHALL COMPLY WITH MNDOT SPECIFICATION 3877 TYPE B SELECT TOPSOIL. MIXTURE SHALL BE FREE FROM HARDPAN, RUBBER, STONES, CHEMICALS, NOXIOUS WEEDS, ETC. SOIL MIXTURE SHALL HAVE A PH BETWEEN 6.1 AND 7.5 AND 5-15-10 FERTILIZER AT THE RATE OF 5 POUNDS PER CUBIC YARD. IN PLANTING BEDS INCORPORATE THIS MIXTURE THROUGHOUT THE ENTIRE BED BY ROTOTILLING IT INTO THE TOP 12" OF SOIL.

19. ALL PLANTS SHALL BE GUARANTEED FOR ONE COMPLETE GROWING SEASON (APRIL 1 – NOVEMBER 1), UNLESS OTHERWISE SPECIFIED. THE GUARANTEE SHALL COVER THE FULL COST OF REPLACEMENT INCLUDING LABOR AND PLANTS.

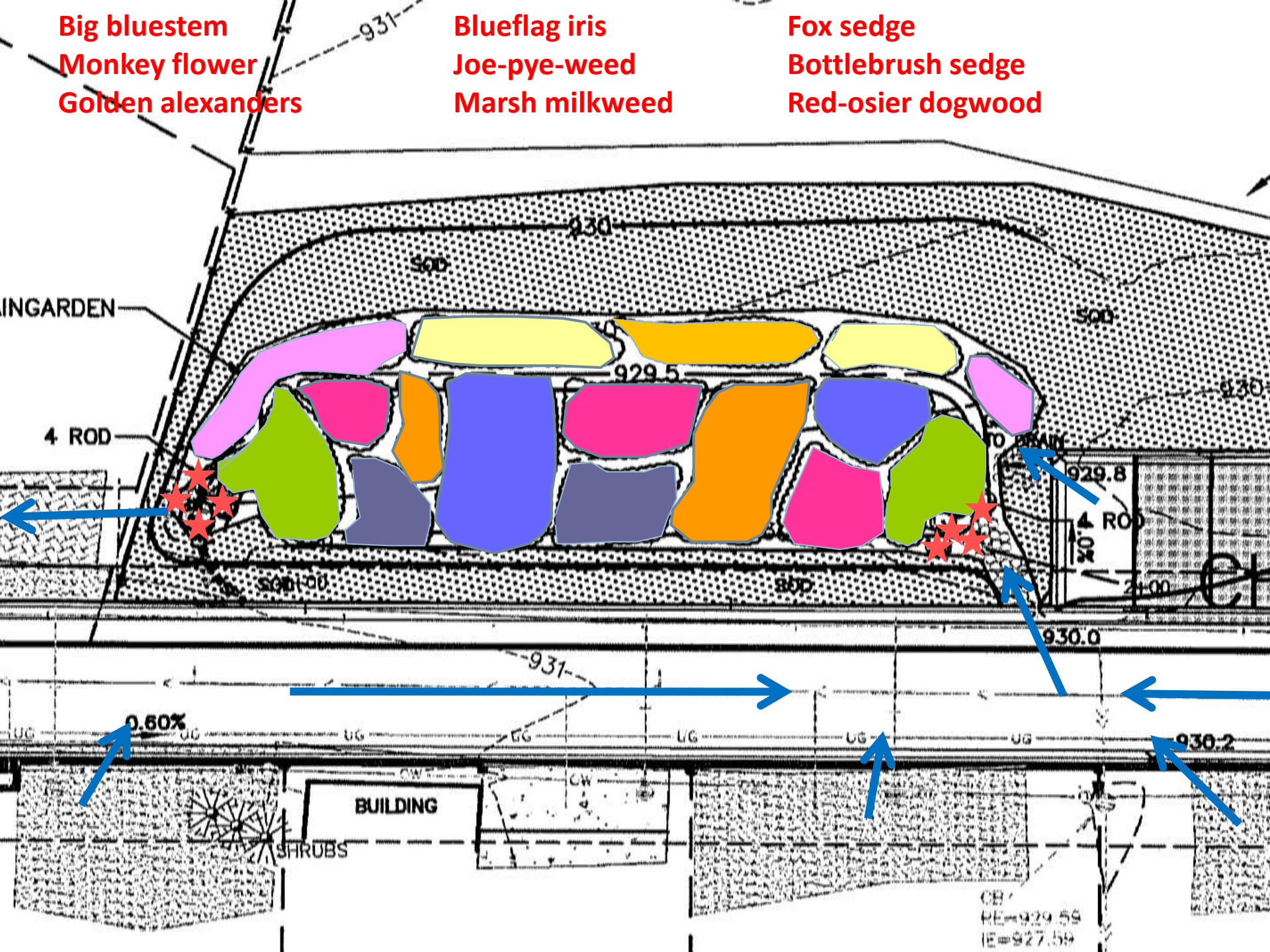
20. CONTRACTOR SHALL NOTIFY THE LANDSCAPE ARCHITECT AT LEAST 3 DAYS PRIOR TO PLANNED DELIVERY. THE CONTRACTOR SHALL NOTIFY THE LANDSCAPE ARCHITECT AT LEAST 24 HOURS IN ADVANCE OF BEGINNING PLANT INSTALLATION.

21. SEASONS/TIME OF PLANTING. NOTE: THE CONTRACTOR MAY ELECT TO PLANT IN OFF-SEASONS ENTIRELY AT HIS/HER RISK.
DECIDUOUS POTTED PLANTS
APRIL 1–JUNE 1, AUG. 21–NOV. 1
DECIDUOUS B&B
APRIL 1–JUNE 1, AUG. 21–NOV. 1
EVERGREEN POTTED PLANTS
APRIL 1–JUNE 1, AUG. 21–OCT. 1
EVERGREEN B&B

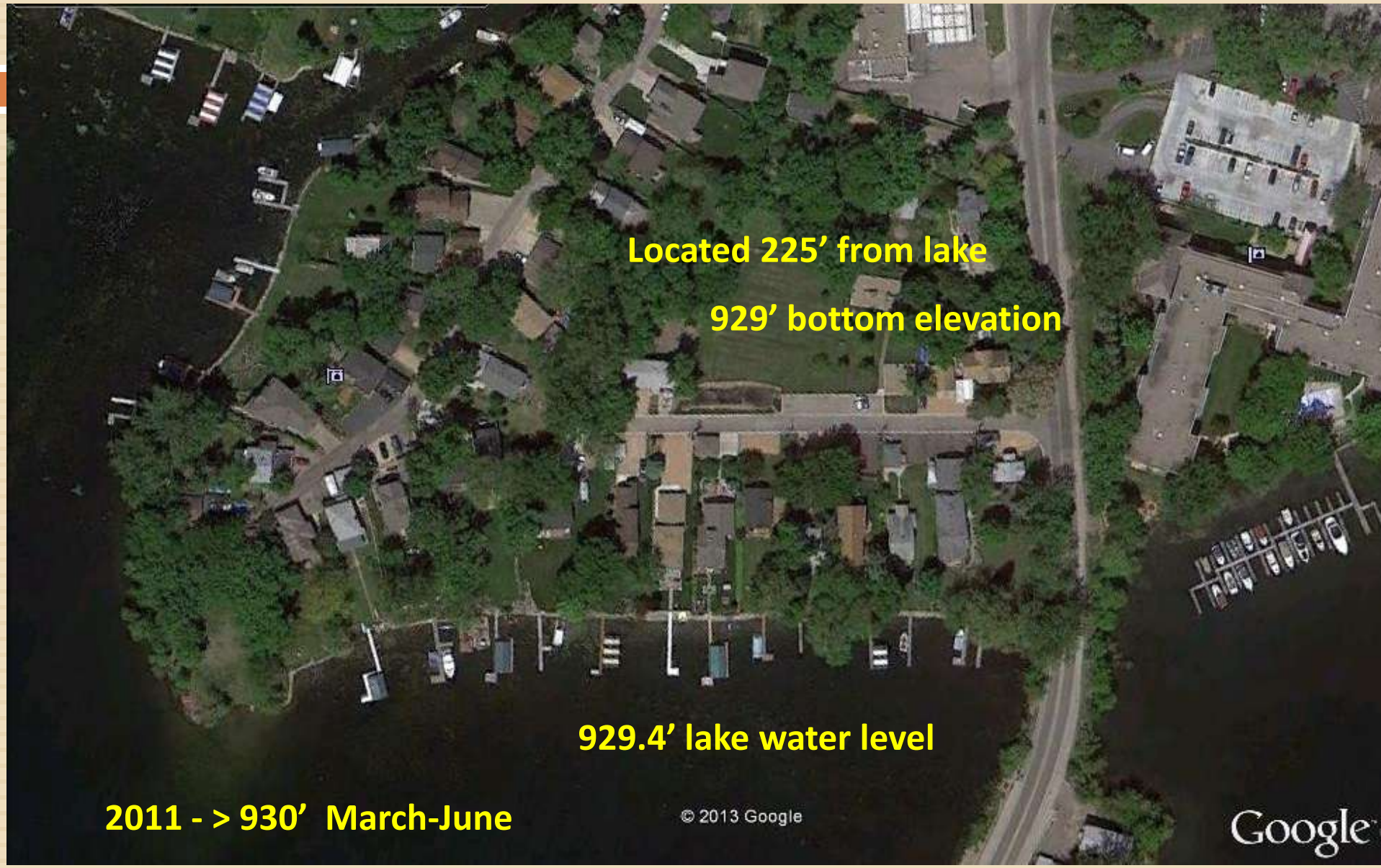
Big bluestem
Monkey flower
Golden alexanders

Blueflag iris
Joe-pye-weed
Marsh milkweed

Fox sedge
Bottlebrush sedge
Red-osier dogwood




2010
Goo


Located 225’ from lake
929’ bottom elevation
929.4’ lake water level
2011 - > 930’ March-June
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07/15/2010


08/19/2010


09/15/2010